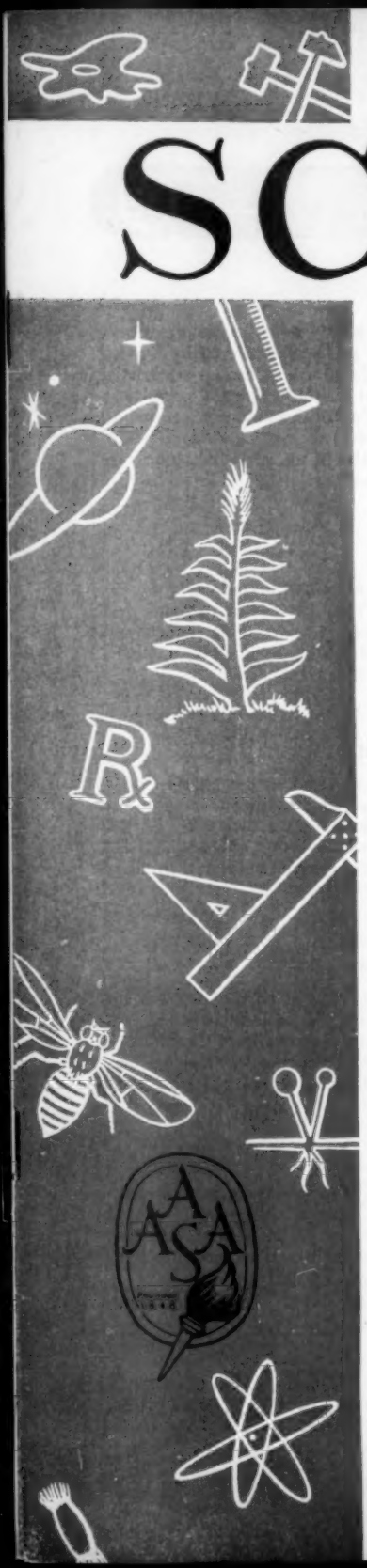

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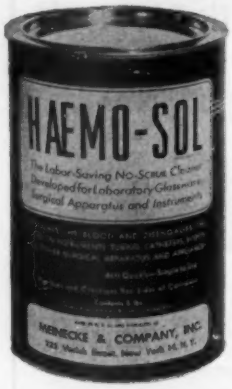

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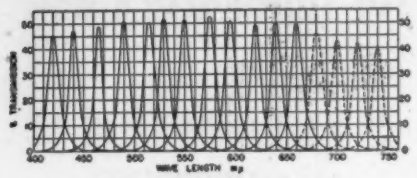

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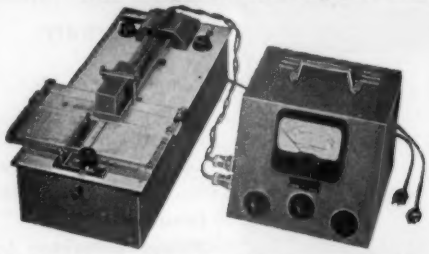

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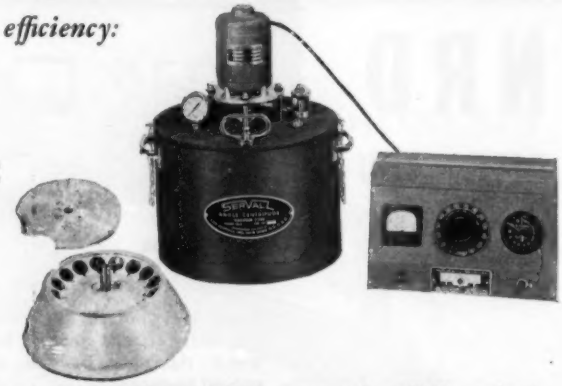

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The United States Weather Bureau

ALMOST 85 years ago, in the wake of storm disasters to coastal and lake shipping, Congress established a national weather service to take observations and give "advance notice of the approach and force of storms." The wrecking or sinking of nearly 2000 vessels on the Great Lakes in 1869 alone had underscored the urgency of needs for this service. Today, warning of storms continues to be the foremost duty of the U.S. Weather Bureau. With the warning service steadily improving, the loss of men and ships has declined markedly; lives lost in hurricanes in recent years have been reduced to less than two for every 100 a quarter-century ago. Military aerial reconnaissance has increased the effectiveness of hurricane tracking, and growing use of long-range search radar promises further improvements. Over the years the Bureau's warning services have been extended to blizzards, cold waves, ice storms, crop-damaging frosts, and floods; recently progress has been made in issuing timely warnings on the smallest, most elusive, and most furious storm of all—the tornado.

Another duty of the Bureau under an early directive from Congress was to gather and study weather records in order to "establish the climate." Of course, this old concept of a permanently fixed climate has long since been abandoned in favor of a dynamic climate whose long-term trends and large-scale fluctuations in weather need to be known in advance for sound national planning in agriculture, commerce, and other fields. Because no reliable methods have been discovered to extend weather outlooks beyond 30 days, the Bureau emphasizes research in this vital zone of overlap between weather and climate.

In addition to storm and flood warnings, climatological reports, 30- and 5-day weather outlooks, and daily forecasts, the Bureau provides specialized weather services to aviation, forest fire-control agencies, and horticultural interests. Most of these functions are performed through about 300 local Weather Bureau offices where regular observations are made, and weather information for the public is collected, processed, and disseminated. There are 18 general forecasting centers, 31 aviation forecasting centers, 87 river district offices, 7 river forecast centers, 43 climatological centers, and 3 weather-records processing centers. Observations at Bureau field stations are supplemented by reports from about 250 Civil Aeronautics Administration stations which collaborate with the Bureau, and from military stations, merchant ships, Coast Guard ships, and international exchanges of weather information. More than 11,000 substations in the United States, manned mostly by unpaid observers, provide valuable data for use in the climatological, river and flood, and aviation services.

To improve these various weather services and the scientific base on which they rest, a small group in the Bureau conducts research on atmospheric processes and on physical and dynamic meteorology, with emphasis on applications to weather forecasting; and it develops, tests, and improves instruments for measuring meteorological elements. Among current fields of research and development are cloud physics; atmospheric electricity; objective weather forecasting; numerical weather prediction with the aid of high-speed digital computors; solar, sky, and terrestrial radiation; severe local storm mechanisms; atmospheric pollution; radar meteorology; and automatic weather observation.

Many meteorologists believe that the science is approaching a period of rapid development through use of new facilities in sounding the atmosphere and in computing interrelationships which heretofore had to depend on extrapolation or subjective analysis. The next few years should bring a better grasp of what the digital computor and other facilities can do for meteorology; if results measure up to hopes they will inevitably bring many changes in the ways in which the Weather Bureau does its work and in the applications of meteorology to public service.

F. W. REICHELDERFER, *Chief*
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Spectrophotometry of Intracellular Respiratory Pigments

Britton Chance

Johnson Research Foundation, University of Pennsylvania

PHYSICAL methods that are chemically specific, that are fast enough to measure biochemical processes, and that permit observations to be made on living cells are rare, and spectroscopy has only recently been developed to the point where extensive studies of a wide range of material are possible. Such observations of the integrated action of intracellular enzyme systems are essential complements to the intensive biochemical researches that have succeeded in breaking down the cellular enzyme systems into their soluble components and in reconstructing many important biochemical processes in solution. But the success of these reconstructions and the theories that evolve from them can be evaluated only by comparison with the direct measurements of the *in vivo* system. The physical method is limited in this case to biochemical substances that change their absorption spectra a sufficient amount in response to biological function to permit a satisfactory measurement. In the sequence of respiratory enzymes of mammalian cells we can study in detail the reactions of six components. Table 1 gives the wavelengths at which the six components are most satisfactorily measured. Other cell pigments that do not change their absorption in response to metabolic activity are compensated by suitable methods so that they do not interfere with the study of the active ones.

Methods. Visual spectroscopy of cell pigments in the visible spectrum has been done in detail by MacMunn (*1*), Keilin (*2*), Warburg (*3*), and Japanese workers (*4*). This method is still extremely useful for the rapid identification of the types of cytochrome in various microorganisms. However, this method is best suited for the study of the α and β bands of cytochromes (650 to 500 mμ); the 5- to 10-fold stronger γ bands that lie in the region 440 to 400 mμ cannot be studied effectively by visual spectroscopy (*5*), nor can any measurements be made of reduced pyridine nucleotide (340 mμ).

Spectrographic studies of cytochromes of microorganisms revealed their γ bands (*6*), but the larger light-scattering effects at these shorter wavelengths were superimposed upon the light absorption to give a considerably distorted record.

Millikan's work (*7*) in 1937 pointed the way to our current instruments for the sensitive, selective, and rapid recording of small optical density changes in living cell suspensions and tissues. He used in very simple form two essential features: (i) a differential colorimeter (following Tyndall's principle, *8*) that was responsive only to a change in absorption at two closely spaced wavelength bands, one at the peak of the absorption band of the pigment to be studied; (ii) a biological system that could exist in two clearly defined states, and in which the transition from one to the other could be made rapidly and at will. Thus the relative intensities of the two light beams are adjusted initially to give zero response in one state, the biological system is shifted to the other state, and the magnitude of the absorption of the cell pigment is recorded directly.

Millikan's apparatus was suitable only for measurements of hemoglobin and myoglobin, and the two states studied were aerobic and anaerobic muscle. By using two monochromators and a vibrating mirror for flickering light of two selected wavelengths through the sample and then upon a photocell (*9*), we have made this method suitable for measurements of both the sharp bands of the cytochromes in the visible region and the reduced pyridine nucleotide in the ultraviolet region (*10*) (Fig. 1).

The choice of wavelengths and the method of eliminating interferenee from other pigments is illustrated by Fig. 2. The absolute absorption spectra for the oxidized and reduced states are shown on the left, but since we record only the changes of absorption that occur upon a change between the two states, the curve on the right is also relevant. Thus wavelengths set at

Table 1. Appropriate wavelengths for measurement of respiratory enzymes. The figures in parentheses refer to neutral reference wavelengths used in double-beam spectrophotometry.

O_2 ⟵ cytochrome a_3 ⟵	cytochrome a ⟵	cytochrome c ⟵	cytochrome b ⟵
445 mμ (460)	605 mμ (630)	550 mμ (541)	564 mμ (575)

flavoprotein ⟵	reduced pyridine nucleotide ⟵	substrate
465 mμ (510)	340 mμ (374)	

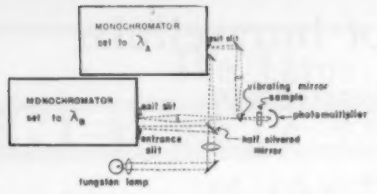

Fig. 1. Double-beam spectrophotometer using quartz or grating monochromators. The sample volume is 0.8 to 10 ml. The vibrating mirror is mounted in a Brown Instrument Co. "Converter" and oscillates at 60 cy/sec.

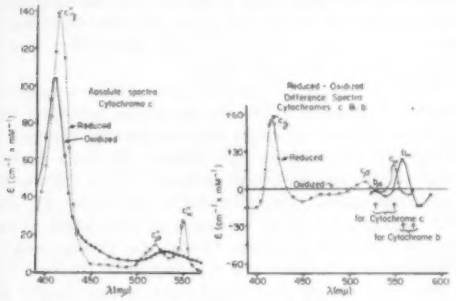

Fig. 2. The spectra of oxidized and reduced cytochrome *c* on the left are subtracted to give the reduced-oxidized difference spectrum on the right. The appropriate wavelengths for measuring cytochrome *c* in the presence of cytochrome *b*, and vice versa, are indicated.

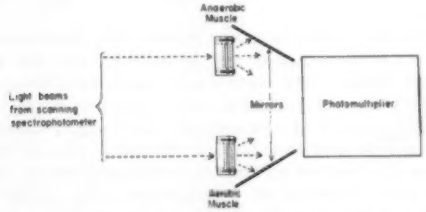

Fig. 3. Optical arrangement suitable for measuring the reduced-oxidized spectrum for the respiratory pigments of a pair of frog sartorius muscles.

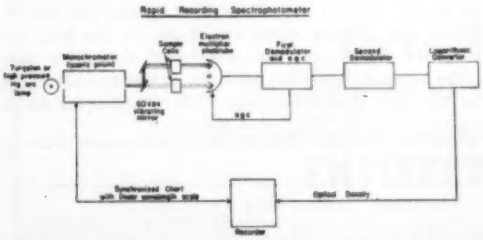

Fig. 4. Split-beam recording spectrophotometer constructed to measure difference spectra. The vibrating mirror is mounted on a Brown "Converter" and its switch contacts select wave forms of the photomultiplier output corresponding to the two-beam positions.

550 and 541 mμ are suitable for cytochrome *c* and will be insensitive to cytochrome *b*, which shows no significant change in absorption for these two wavelengths. If, on the other hand, cytochrome *b* is to be measured, 564 and 575 mμ are a suitable pair of wavelengths. The pairs of wavelengths in Table 1 are chosen to give optimal selectivity in the measurement of these six respiratory enzymes.

With a large number of bacterial suspensions, it has been possible to use a single-beam technique in which the photocurrent caused by the transmitted light is "bucked out" by an adjustable voltage (*9*). The optical density change is recorded when the aerobic suspension becomes anaerobic (*11*). This method is satisfactory for material that does not settle rapidly and does not change its light scattering on the transition from aerobiosis to anaerobiosis. These conditions are apparently fulfilled with suspensions of bacteria, yeast, and muscle homogenates; many measurements of cytochromes have been made in this way (*12*). In fact, intracellular reduced pyridine nucleotide was first recorded by this method (*11*).

A method (*13*) that is particularly suited to recording the spectrum representing the differences of light absorption between two metabolic states of a living system is illustrated by Fig. 3. In this case the paired sartorius muscles differ in oxygen tension—one is aerobic, the other anaerobic—and they are illuminated with the light of the same wavelength. Variation of the wavelength of light gives the difference spectrum, provided that electronic or other means are supplied for maintaining constant photocurrent when the light falls upon only one sample. A method for accomplishing this by control of the dynode voltage of the photomultiplier is illustrated by Fig. 4 and has been described by Yang and Legallais (*14*).

Instead of recording the difference between two biochemical states of the same material, some investigators record the difference of absorption between the biological material and a substance that approximates its light-scattering properties such as filter paper (*15*) or oiled filter paper (*16*) (Duysens has apparently not yet taken advantage of this principle in his apparatus, *17*). In this case the absorption of metabolically inactive pigments is also recorded. The difference spectrum resulting from two metabolic states must be obtained by subtraction of two separate recordings from such a device, and the selectivity that can be obtained is diminished.

Limitations. The performance of current methods (Fig. 1) in which a reasonably large sample is available (~10 ml) is set largely by the brightness of the light source (steradiance), the accuracy with which the light intensity can be stabilized (there is intrinsic "noise" in the light from tungsten lamps, *9*), the aperture and dispersion of the monochromator, and the sensitivity of the photocathode (*18*). "Head-on" types of photomultipliers have been found to be very suitable for gathering the light from the sample. Good results are obtained for 10-ml samples with a cuvette area approximately equal to the area of the

photosurface (10 cm²). On the other hand, samples of 0.8 ml have been used in a number of studies where the material available is limited. In fact, the thorax of a housefly, crushed and suspended in 1 ml, gives adequate deflections for spectroscopic studies of rapid enzyme reactions.

Controls. The light absorption of respiratory enzymes in cells is considerably lower than that of hemoglobin in the erythrocyte (*19*) or chlorophyll in the chloroplast (*17*), and the complex optical situation due to light losses in the pigment granules has not been observed. Probably the most direct control on this point is provided by the following experiment. A difference spectrum of a turbid homogenate containing cytochrome *c* attached to cell fragments is recorded by the method of Fig. 4. Sodium cholate is then added to both samples. The turbidity nearly completely disappears, and cytochrome *c* is now in true solution, as is shown by chemical tests. The difference spectrum is again recorded and is essentially unchanged. A similar control has been carried out by comparing the difference spectra of bacteria before and after treatment with lysozyme to dissolve the cell wall—again no significant change is observed (*20*). Even in the case of measurements at 340 mμ, where light-scattering effects would be expected to be severe, the assay of the reduced pyridine nucleotide content of baker's yeast agrees with chemical assays (*11*).

Accessory techniques. Since the most incisive method involves the difference between two biochemical states of the living cells, accessory methods to determine whether those states have been established are highly desirable for, and in some cases essential to, a successful result. In the case where aerobic and anaerobic states are compared, a platinum microelectrode is inserted directly into the cuvette, and oxygen concentration is measured polarographically (*21*). A vibrating electrode (*22*) has a more rapid recovery time following stirring of the solution and is illustrated in Fig. 5 (*23*).

In cases where the two biochemical states differ with respect to rates of fermentation, the glass electrode may be used to measure the rate of acid production in lightly buffered suspension mediums of appropriate *p*H, as is illustrated by Fig. 5.

An illustration of the use of these two accessory techniques in the study of the reactions of reduced pyridine nucleotide enzyme systems in a suspension of yeast cells is afforded by Fig. 6 (*10*). Here there are three metabolic transitions: (i) Addition of glucose to the starved, quiescent yeast initiates rapid respiration, as indicated by the abrupt slope of the platinum microelectrode trace. This respiration is caused by a reduction of pyridine nucleotide. (ii) The initiation of aerobic fermentation is indicated by the delayed rise of the *p*H recording. (iii) The onset of anaerobiosis is marked by the inflection of the platinum microelectrode trace. The spectrophotometer then records a large increase in the reduction of pyridine nucleotide.

Thus this combination of accessory methods records the metabolic state of the cell suspension, and the spectrophotometric method records fundamental changes in the pattern of enzymatic activities that may control the metabolism. In short, this method provides the features of Warburg's techniques for measuring the over-all processes of respiration and fermentation and, at the same time, gives a direct assay of the steady-state levels of various respiratory catalysts involved in these processes.

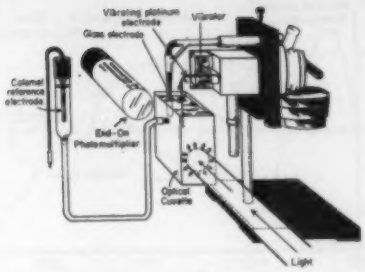

Fig. 5. Arrangement permitting simultaneous measurement of respiration with the platinum electrode, fermentation by means of the change of *p*H in a lightly buffered medium as recorded by the glass electrode, and changes in the steady-state levels of the respiratory enzymes by the double-beam spectrophotometer.

Identification of intracellular respiratory enzymes. It has been possible to survey the types of respiratory enzymes in a wide variety of materials by the methods of Figs. 1 and 4. As an example of our results on mammalian cells, Fig. 7 (left) shows the difference spectrum of aerobic and anaerobic ascites tumor cells. These cells are one of the most convenient sources of a homogeneous suspension of the mammalian type. The peritoneal cavity of one cancer-bearing mouse contains adequate material for a number of measurements. The difference spectrum shows clear absorption bands due to cytochromes a_3, a, and c, flavoprotein,

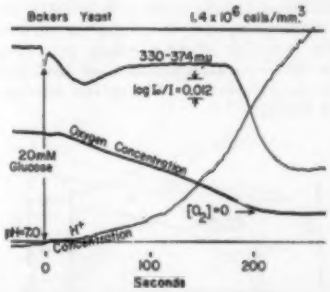

Fig. 6. Recording obtained with the combined methods of Fig. 5. Respiration and subsequently fermentation are initiated in an aerobic starved yeast cell suspension by adding glucose. The downward deflection of the spectrophotometric trace (optical density change at 330 mμ minus that at 340 mμ) shows the reduction of intracellular pyridine nucleotide.

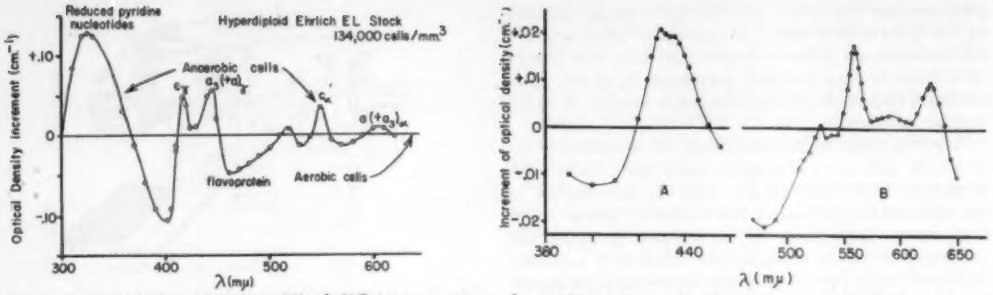

Fig. 7. (Left) Reduced minus oxidized difference spectrum for ascites tumor cells obtained by the method of Fig. 4 (Ehrlich hyperdiploid cells obtained through the kindness of T. S. Haushka). The absorption bands of the respiratory enzymes are identified on the figure. (Right) Reduced-oxidized spectrum for a suspension of *Aerobacter aerogenes*. The cell concentration in *B* is 4 times that in *A*.

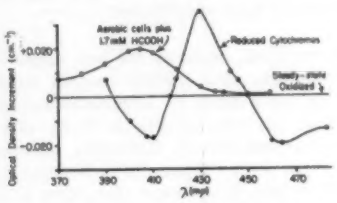

Fig. 8. Evidence for the existence of the primary catalase hydrogen peroxide complex in cells of *Micrococcus lysodeikticus*. Addition of 1.7 mM formate cause the decomposition of the complex and the characteristic rise of absorption at 405 mμ. The reduced-oxidized difference spectrum is included for comparison.

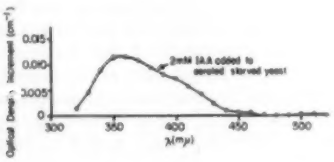

Fig. 9. Evidence for the compound of DPN and glyceraldehyde-3-phosphate dehydrogenase in aerobic starved yeast cells. Addition of IAA causes this compound to decompose with the disappearance of the characteristic absorption band shown here. The optical density decreases upon IAA addition.

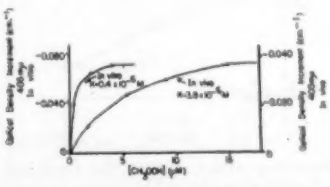

Fig. 10. Comparison of the methyl hydrogen peroxide titration of intracellular catalase of *M. lysodeikticus* with the titration of pure crystalline enzyme from these bacteria. See text for explanations for the diminished affinity of the enzyme *in vivo*.

and reduced pyridine nucleotide at the appropriate wavelengths (Table 1). Cytochrome *b* is present at a low concentration in these tumor cells and is difficult to detect without poisoning the cells with antimycin-A (*24, 25*).

A rather different example is represented by the difference spectrum of aerobic and anaerobic *Aerobacter aerogenes* (Fig. 7, right). In the visible region, peaks are due to cytochrome a_2, a_1, and *b*, at 630, 590, and 560 mμ, respectively. The γ bands of these pigments fuse to make a broad peak at 430 mμ (*12*).

Identification of intracellular enzyme-substrate compounds. Based upon *in vitro* studies of enzyme-substrate compounds (*26*), it seemed likely that such compounds would exist as reactive intermediates in metabolizing cells. This expectation is realized in the experiment recorded in Fig. 8. The catalase hydrogen peroxide complex has been found to react rapidly with formate *in vitro*. The complex is decomposed in this reaction, and the free enzyme is released. If the complex exists in the living cell, a similar reaction is to be expected and is verified by the increase of optical density caused by adding formate to aerobic bacterial cells. The spectroscopic shift is that expected on the basis of *in vitro* data and other chemical tests (reactions with methyl hydrogen peroxide and with azide identify the catalase complex positively, *27*). Such a demonstration is very important in our understanding of the level and the metabolism of hydrogen peroxide in the living cell.

In vitro it has been found that glyceraldehyde-3 phosphate dehydrogenase combines with diphosphopyridine nucleotide (DPN), and the enzyme-DPN compound has a characteristic absorption peak at 365 mμ (*28*). A similar *in vitro* reaction has been observed for the yeast enzyme (*29*). The presence of this enzyme-DPN compound may be readily detected *in vitro* by its rapid decomposition by iodoacetic acid (IAA) which causes the 365-mμ absorption band to disappear. Figure 9 shows the application of this test to a suspension of aerobic starved yeast cells. The spectroscopic change caused by IAA *in vivo* is very similar to the *in vitro* effect and leads us to the conclusion that about 20 percent of the intracellular DPN of the yeast

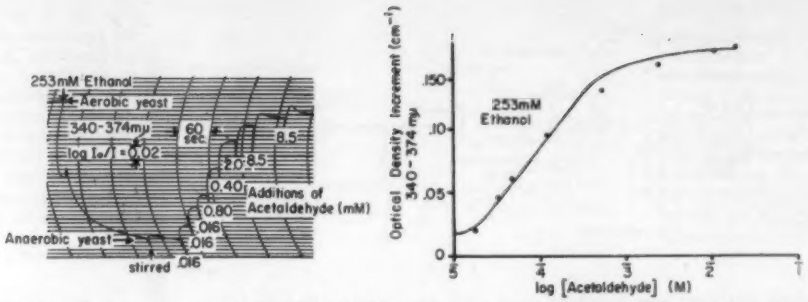

Fig. 11. (Left) Reduction of pyridine nucleotide of baker's yeast caused by ethanol addition followed by the oxidation of the intracellular pyridine nucleotide caused by a series of additions of acetaldehyde. (Right) Evidence that the oxidation of intracellular reduced pyridine nucleotide by acetaldehyde (points) follows a simple mass law equation (solid line).

cell may be bound to this enzyme (*27*). This result gives some insight concerning the intracellular localization of DPN on a molecular basis.

Quantitative studies of intracellular enzyme systems. The methods we now use are of sufficient stability and sensitivity that it is possible to carry out detailed studies of intracellular enzyme systems. For example, intracellular catalase may be titrated with peroxide to form the catalase complex I (*26*) as is illustrated by Fig. 10. In this case we may compare the result with the *in vitro* titration. More peroxide is required to form the intracellular compound, probably because the cell contains hydrogen donors and, in addition, the cell wall may provide a diffusion barrier to the peroxide.

The DPN system of anaerobic cells becomes completely reduced when an excess of ethanol is added to the starved cells, as is indicated by the downward deflection of the trace of Fig. 11 (left). A titration with aldehyde causes oxidation of the DPN system that is influenced by the alcohol dehydrogenase equilibrium (*10*). These titration data (points of Fig. 11, right) closely follow the solid curve drawn from simple equilibrium considerations. Similar titrations may be carried out with acids and bases that also influence the DPN-DPNH equilibrium, and the possibility that such shifts in the steady-state levels of the pyridine nucleotide system may govern pathways of metabolism can now be directly investigated (*10*).

Metabolic correlations. Since these methods permit a simultaneous recording of respiration (as oxygen disappearance measured by the platinum microelectrode) and fermentation (as acid production measured by the glass electrode), it is possible to correlate changes in the enzymatic systems with these metabolic activities. An interesting correlation in a suspension of ascites tumor cells is illustrated by the three traces of Fig. 12. The ascites cells as harvested from the mouse have a slow respiration and very little fermentation, as is indicated by the platinum and the glass electrode traces. Upon addition of glucose, the reduction of pyridine nucleotide occurs (as is indicated by the downward deflection of the spectrophotometric trace) and within a minute rapid fermentation is initiated (as is indicated by the rise of the glass electrode trace). The increased reduction of pyridine nucleotide does not, however, increase the respiration; instead, a decrease of respiration is observed. The amount of reduced pyridine nucleotide clearly does not set the slow pace of respiration in these tumor cells.

Photochemical reaction kinetics. The kinetics of photochemical reactions can be followed in cell suspensions with the modification of the apparatus of Fig. 1 illustrated in Fig. 13. The cuvette containing the cell suspension is illuminated with photodissociating light, and the resulting spectroscopic changes are measured by the double-beam spectrophotometer that is rendered unresponsive to the constant photodissociating light because of the capacitance coupling in the amplifier and because of the color filters in front of the photocell (*13*). A typical record of the kinetics of photodissociation of the carbon monoxide compound of cytochrome a_3 in yeast cells and its recombination in the dark is shown in Fig. 14 (*30*). By a comparison of the kinetics of these reactions with those of myoglobin-CO for which the molecular ex-

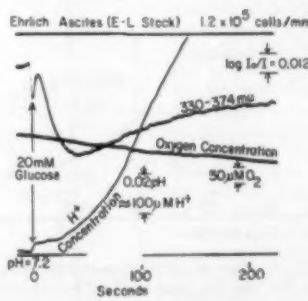

Fig. 12. Interrelationships of pyridine nucleotide reduction, and changes in respiration and fermentation caused by adding glucose to a suspension of aerobic ascites tumor cells. Data measured as indicated by Fig. 5.

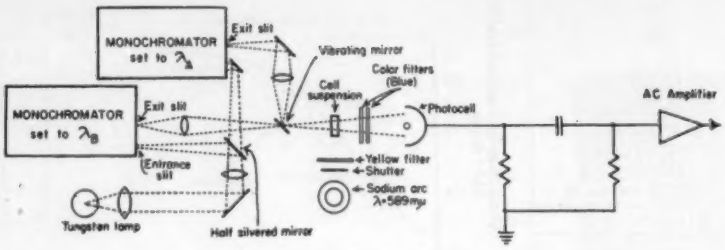

Fig. 13. A modification of the apparatus of Fig. 1 for spectroscopic measurements of the kinetics of photochemical reactions. The capacitance coupling in the amplifier, together with the blue filters, renders the measurement circuit insensitive to the illumination of the cell suspension with yellow light.

tinction coefficient (*31*) and quantum yield (*32*) are known, the molecular extinction coefficient for the carbon monoxide compounds of cytochromes a_3 and a_1 have been computed (*30*).

Photosynthetic reactions in purple bacteria, for example, ***Rhodospirillum rubrum,*** are excited by infrared radiation beyond the response of the Cs-Sb photosurface, and in this case no protecting filter in front of the photocell is required. Figure 15 shows the measurement of the kinetics of oxidation of respiratory pigments of an anaerobic suspension of *Rhodospirillum rubrum* upon illumination with infrared light, followed by a reduction in the dark. The kinetics of this reaction are diphasic and, in agreement with our action spectrum for this effect, lead us to the conclusion that the whole chain of respiratory enzymes is involved in this photochemical effect (*33*)—a result contrary to that of Duysens who first demonstrated this reaction (*34*). Lundegårdh has also reported an action spectrum involving cytochromes upon illumination of *Chlorella,* but his technique does not permit the recording of rapid reactions (*35*).

Studies of very rapid intracellular reactions. It has recently been possible to apply the accelerated- and stopped-flow methods (*36, 37*) to the measurement of the kinetics of rapid intracellular enzyme reactions in the time range 5 to 30 msec. An intracellular reaction of particular interest is the oxidation of reduced cytochrome oxidase by molecular oxygen. These measurements are most efficiently carried out in the regenerative flow apparatus shown in Fig. 16. In a typical experiment of this type the anaerobic suspension of yeast cells is driven downward from the large upper chamber into the mixing chamber and observation tube at flow velocities of 1 to 5 m/sec. The small syringe, driven simultaneously downward, contains an oxygenated solution that is mixed with the yeast just before it reaches the observation chamber, which has a 1-cm² cross section and is 1 cm long.

The material passing out of the observation tube is collected in a large syringe that provides quick stopping for the flow as used by Gibson (*37*). Since the yeast cells use up the added oxygen in a short time, they may be transferred into the upper syringe and used in subsequent experiments—a very important feature when the volume of reactants is limited.

Figure 16 includes a typical experimental record; the lower trace represents the spectrophotometric data, the upper one the flow velocity. The anaerobic yeast in the observation tube is replaced by the mixture of oxygen and anaerobic yeast when the flow is started (as indicated by the downward deflection of the upper trace). The oxidation of intracellular cytochrome *c* by oxygen and cytochrome oxidase has proceeded to about half-maximal completion at the value of flow velocity used—corresponding to a first-order velocity constant of 70 sec^{-1}. When the flow stops the reaction reaches the maximal steady-state oxidation of cytochrome *c*, which is maintained for 10 sec, when the added oxygen is used up.

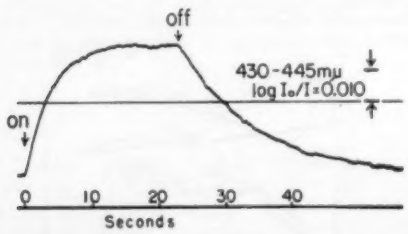

Fig. 14. The kinetics of photodissociation and dark recombination for the CO compound of cytochrome a_3. The yeast cell suspension was illuminated at 589 mμ as is shown in Fig. 13. An upward deflection of the trace corresponds to a decrease in optical density at 430 mμ. The calculated value of the molecular extinction coefficient for the a_3-CO compound is 12 $cm^{-1} \times mM$ at 589 mμ.

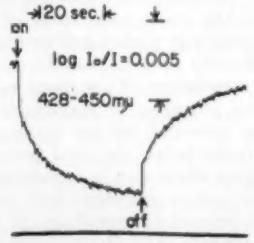

Fig. 15. The kinetics of the oxidation of cytochromes in an anaerobic suspension of *R. rubrum* caused by infrared illumination. A downward deflection of the trace corresponds to a decrease in optical density at 428 mμ. Upon the cessation of illumination the dark reduction was initiated and proceeded to completion after the recording shown here was stopped.

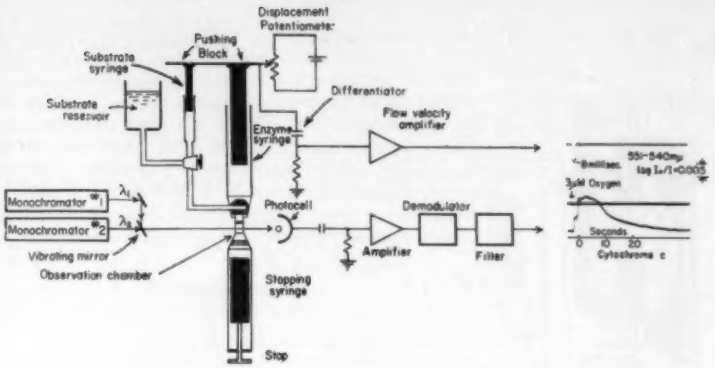

Fig. 16. The regenerative flow method for the measurement of very rapid chemical reactions in suspensions of intact cells in the particular experimental result shown at the right, anaerobic yeast cells are mixed with 3 μM oxygen, and the oxidation of the intracellular ferrocytochrome *c* is recorded by the double-beam spectrophotometer.

This flow apparatus has adequate speed to permit detailed studies of the relative speeds of oxidation of the members of the respiratory sequence of various cells (Table 1). It has been found that the oxidation reaction proceeds extremely rapidly through cytochrome *c* and somewhat more slowly through cytochrome *b*, flavoprotein, and reduced pyridine nucleotide, the oxidation of cytochrome *b* being a rate-limiting step, for example, in baker's yeast.

It is often desired to record the difference spectrum between anaerobic cytochromes and those oxidized a short time after adding oxygen in order to determine whether any labile intermediate compounds involved in the oxidation reactions of the respiratory chain can be observed. An apparatus similar in principle to that of Fig. 16, but with larger volumes of reactants, permits a flow of about 30-sec duration—long enough to permit the recorder of Fig. 4 to plot the difference spectrum corresponding to the extent of oxidation of the respiratory pigments 30 msec after adding 23 μM of oxygen (Fig. 17). This record clearly shows that the cytochromes oxidized in this short time are *a*, *c*, and a_3; the bands of flavoprotein at 465 mμ and reduced pyridine nucleotide at 340 mμ are conspicuously absent at the shorter time.

Spectroscopic studies of intact tissues. Lundegårdh has made a number of interesting observations of the cytochromes of cut bundles of wheat roots (*15*). The roots are held in a circular tube about 1 cm in diameter that is illuminated with monochromatic light, and the light scattering is compensated by a piece of filter paper. The roots are bathed in various solutions to cause metabolic changes. The results are, at the present time, restricted to the cytochromes; no data on pyridine nucleotides have been published.

It has recently been possible to make detailed kinetic studies of the effect of contraction upon the steady state of pyridine nucleotide enzyme systems of frog sartorius muscle (*38*). The flow chamber for the muscle is illustrated by Fig. 18. The perfused muscle is held between two perforated Lucite sheets that allow the muscle to be bathed continuously in Ringer's solution

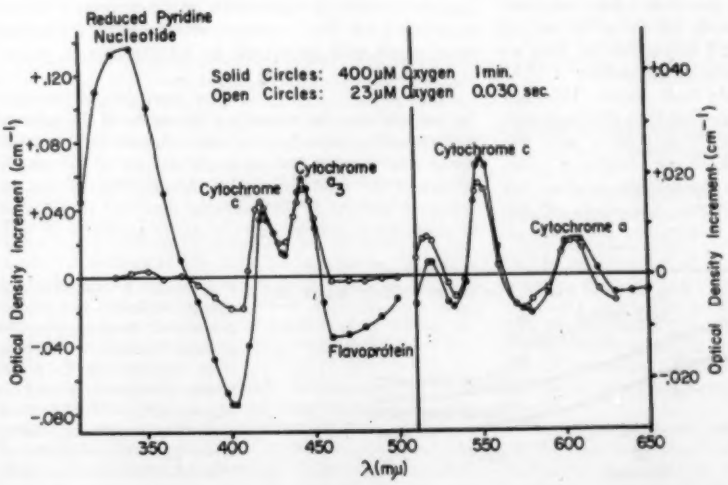

Fig. 17. Recording of the respiratory pigments that are oxidized 30 msec after adding 23 μM of oxygen to anaerobic yeast cells (open circles). This spectrum may be compared with the result obtained 1 min after adding 400 μM of oxygen to anaerobic cells (solid circles). To assist in the recognition of the absorption bands of the reduced pigments that disappear upon addition of oxygen, the data are plotted as a usual reduced minus oxidized difference spectrum and may therefore be directly compared with other data. These results were obtained with a combination of the apparatus of Fig. 4 and a modification of that of Fig. 16.

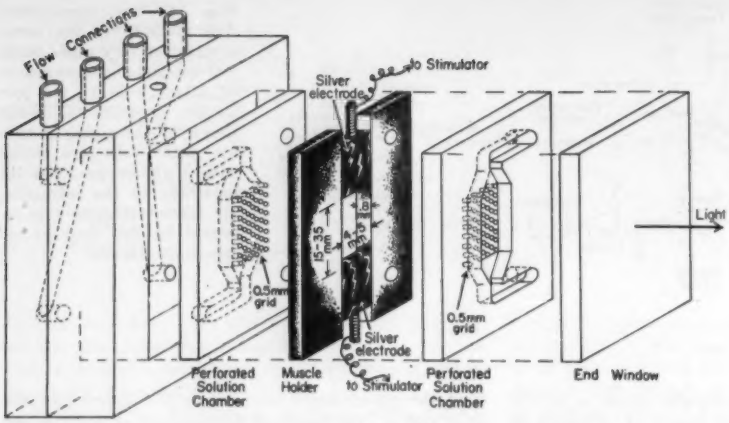

Fig. 18. Flow chamber for spectroscopic observations of changes in the steady-state level of reduced pyridine nucleotide enzyme systems in aerobic frog sartorius muscle. The flow chamber is made of Lucite (free of ultraviolet-absorbing dyes).

containing various other reagents as desired. The muscle ends are in contact with two silver electrodes for electric stimulation. The muscle is illuminated by the double-beam spectrophotometer of Fig. 1, which is not appreciably affected by slight shifts in the position of the muscle caused by contraction, or by light-scattering changes in the muscle when the two wavelengths used are closely spaced.

When aerobic muscle contracts, current theories state that adenosine diphosphate (ADP) produced in the contraction is converted back to adenosine triphosphate by the oxidative phosphorylation system of muscle mitochondria or sarcosomes. In liver mitochondria, it has been found that oxidative phosphorylation of ADP causes an oxidation of the steady state of reduced pyridine nucleotide (*39*). The effect of muscular contraction upon the steady state of pyridine nucleotide of aerobic frog sartorius muscle during a series of twitches at low temperature is recorded by the double-beam technique, as is shown in Fig. 19. The abrupt upward deflection of the trace upon initiation of the contractions corresponds to an oxidation of reduced pyridine nucleotide; this persists as long as the contractions are maintained. Thereafter a slow recovery to the previous steady state occurs. Although this technique is only in its preliminary development, the particular reaction of Fig. 19 may be of some use in evaluating how rapidly ADP or inorganic phosphate released in muscular contraction reaches the oxidative phosphorylation system. The study of the steady state of intracellular respiratory pigments of muscle and other tissue in which hemoglobin and myoglobin do not interfere with the spectroscopic observation presents some fascinating possibilities for the future.

Future developments. There are a number of important problems that cannot be adequately solved with present spectroscopic methods because the optical density change is either too small to measure or occurs too rapidly. When the amount of material available is limited, such problems can be taken up only when brighter and more stable light sources, better monochromators, and more sensitive photosurfaces become available. Thus future developments in this field are closely tied to physical aspects of the techniques.

The importance of proper use and selection of biological material can scarcely be overemphasized. Since the philosophy of the method is centered about the measurement of spectrophotometric changes that accompany changes in the biological state, it is important to know how to cause such changes and which organisms respond maximally. In this respect it should be pointed out that a suitable change in the biological state might well be caused by adaptations in microorganisms.

There are at the present time a number of interesting possibilities for extending the scope of the present studies with currently available equipment. The ability to make rapid and accurate assays of the steady state and the total content of the respiratory enzyme sequence may be of considerable practical importance in evaluating growth and metabolic patterns of cells

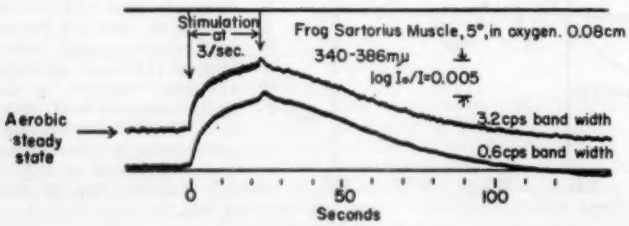

Fig. 19. A spectroscopic change caused by the contraction of frog muscle. The upward deflection of the trace corresponds to a decrease of optical density at 340 mμ and is found to have an action spectrum corresponding to the oxidation of reduced pyridine nucleotide.

and tissues, and possibly in monitoring the steady state appropriate to a particular metabolic function.

Acknowledgment. I wish to acknowledge the fine contributions to instrument design made by V. Legallais and C. C. Yang. In addition, the collaboration of Lucile Smith, G. R. Williams, C. M. Connelly, and George Ludwig in various phases of this research is gratefully acknowledged. This work has received support from the U.S. Public Health Service, the Office of Naval Research, and the National Science Foundation.

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Semiempirical Study of the H_2Cl Transition Complex through the Use of Hydrogen Isotope Effects

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Brookhaven National Laboratory

Linear and triangular structures for the H_2Cl transition complex have been analyzed in terms of normal vibration theory and by an evaluation of the experimental data on the effect of hydrogen isotope substitution on the rate of reaction of hydrogen molecules and chlorine atoms. The frequencies of the bending vibrations are probably small enough that their contribution to the relative rates can be expressed in terms of a small quantum correction of the order of $(hc/kT)^2\,(\omega_H^2 - \omega_{D,T}^2/24)$. The near classical behavior of the bending frequencies for both linear and triangular structures of the H_2Cl complex serves to reduce the ratio of the frequency factors, $A_H/A_{D,T}$, in the Arrhenius equation from that expected from structural considerations alone. Quantitative agreement is found between the caluculated and experimentally determined frequency factor ratios.

The "symmetrical" stretching frequencies, for both linear and triangular complexes, respectively, have been evaluated from the relative rates of reaction of H_2 and HT with chlorine atoms at 0°C and the known properties of the isotopic hydrogen molecules. This empirically evaluated parameter together with thermodynamic data and an estimate of the tunnel correction suffice to calculate the relative rates of reaction of the isotopic hydrogen molecules with chlorine atoms as a function of temperature. Good agreement is found between the calculated rates for both linear and triangular structures and the available experimental data on HD, D_2, and HT.

Work was performed under the auspices of the U.S. Atomic Energy Commission.

Diffusion and Sedimentation of a Weak Polyelectrolyte, Carboxymethyl Amylose (CMA)

Charles O. Beckmann and Anthony G. Scott,
Columbia University

The diffusion curve (dc/dx vs. x) of CMA solution against water is not of the ideal Gaussian form but possesses a shoulder on the solvent side of the boundary. This anomaly has also been observed for the nucleic acids. Analysis shows the diffusion coefficient (D) to be a complicated function of the concentration, rising sharply as the concentration increases from zero, going through a maximum, decreasing to a minimum and then rising very slowly.

These variations stem from the superposition of two effects that arise from the increase in ionization with decreasing concentration. On the one hand, the increase in negative charge on the polymer molecule causes its

extension owing to intramolecular repulsions and, hence, a decrease in D. On the other, the increase in number of more rapidly diffusible hydrogen ions increases the drag on the polymer molecule and, hence, causes an increase in D. The former mechanism dominates the situation in very dilute solution, as is substantiated by viscosity measurements, and the latter dominates the situation in intermediate concentrations.

The effects are reflected in the appearance of the sedimentation curves of CMA which show two almost resolvable peaks, which in this case, however, do not indicate the presence of two molecular species. The effects described can be suppressed by a sufficiently high concentration of salt.

Natural Occurrence of Polyacetylene Compounds

Marjorie Anchel, *New York Botanical Garden*

Polyacetylene compounds from biological sources were almost unknown until a few years ago when occurrence in higher plants and in fungi was reported. A complete series of such compounds, ranging from C_3 to C_{32} has now been isolated. The naturally occurring compounds usually contain double bonds, as well as conjugated triple bonds, and show a variety of functional groupings. Several of the compounds obtained from fungi contain also an allenic grouping and undergo an interesting isomerization, the product of which is not allenic but contains an additional acetylenic group. The metabolic significance of the polyacetylenes is unknown, but a number of them are known to be toxic to microorganisms or to higher animals.

Recent Results on the Heat Capacities of Superconducting Metals at Liquid Helium Temperatures

Henry A. Boorse, *Columbia University*

Detailed measurements have been made of the normal and superconducting heat capacities of Nb, Va, Ta, and La. With some exceptions, the heat capacity in the normal state can be represented in the usual manner by the sum of a Debye term and a Summerfeld term. In the superconducting state none of the afore-mentioned elements displays the usually assumed T^3 dependence. Values of the electronic heat capacity appropriate to the superconducting state are compared with the predictions of the Heisenberg-Koppe theory and with those of the "α-model." The former gives a better fit with the experimental data, but departures at the lowest temperatures appear to be beyond the experimental error.

Superheating of Water as a Measure of Negative Pressure

Lyman J. Briggs, *National Bureau of Standards*

Clerk Maxwell (*Theory of Heat*, 1871) first directed attention to the fact that the superheating of water provides a measure of its negative pressure at high temperatures. Superheated water (or any other liquid) in a tube open to the atmosphere sustains a negative pressure equal to its saturation vapor pressure at the observed temperature, less the pressure of the atmosphere. This interesting fact appears to have been entirely overlooked in recent reviews of the literature of negative pressure.

Defour suspended droplets of water in a mixture of wintergreen oil and linseed oil of equal density, which he heated to 180°C without the water exploding. This corresponds to a negative pressure P_N of about 9 atm. Harvey *et al.*, after subjecting water to a hydrostatic pressure of more than 1000 atm in order to drive gas nuclei into solution, found that water so treated could be superheated in an open tube to 202°C without exploding ($P_N = 16$ atm).

Kenrick, Gilbert, and Wismer, using a thin-wall capillary U-tube the lower end of which was pluged into the bath for 5 sec, superheated water to 270°C ($P_N = 54$ atm). Using a fine butt-welded thermocouple threaded through a thin-wall capillary U-tube, I have confirmed their conclusion that an immersion time of 5 sec is sufficient to attain the temperature of the bath (within 1°C). Using their method I have superheated water to 264°C before it exploded ($P_N = 50$ atm).

Larmor has shown that the negative pressure of water should vanish at 273°C if the van der Waals equation continuously applies; that it does not so apply is evident from the negative pressure of 54 atm at 270°C derived from the superheating measurements. Apparently the only safe assumption is that the negative pressure becomes zero when the meniscus vanishes at the critical point, 374°C.

Circulating Splanchnic Blood Volume

S. E. Bradley, B. Cominsky, P. Marks, P. Reynell,
Columbia University College of Physicians and Surgeons

The volume of blood held within the splanchnic vascular bed (SBV) may be measured indirectly in dogs and man by a "dilution" technique. Circulating splanchnic plasma volume and red cell mass may be determined simultaneously on the basis of the local dilution of I^{131} labeled human serum albumin and P^{32}-labeled red blood cells. The quantity of these substances dispersed within the splanchnic bed at equilibrium may be estimated from the difference between average concentrations in arterial and hepatic venous blood during equilibration following intravenous administration, multiplied by hepatic blood flow during the same period. This figure divided by the equilibrium concentration yields values for circulating splanchnic plasma volume and red cell mass, respectively. Calculation of mean circulation time indicates that red cells travel more rapidly than plasma through the splanchnic blood vessels. The estimated splanchnic hematocrit is significantly less than the total body hematocrit, suggesting that the SBV is distributed chiefly within the smaller vascular radicles. Changes in SBV during hemodynamic adjustments induced by hexamethonium bromide, hydrazine phthalazine, and hemorrhage indicate that the splanchnic bed participates actively in determining the distribution of blood in the body.

Relationship between Sensitivity to Alternating Electric Stimulation of the Eye (Phosphene Threshold) and State of Adaptation

Johannes Clausen, *Columbia University*

Thresholds of visual sensation (peripheral phosphenes), (in response to sine-wave electric stimulation in the frequency range of 6 to 70 cy/sec), were recorded while the eyes of the subjects were adapted to brightness levels of 0.032, 0.32, 3.2, 32, and 320 ml as well as to total darkness.

When the group averages based on seven observers were plotted as intensity-frequency curves for each state of adaptation, it was found that an increase in the adapting intensity increased the threshold at low frequencies, whereas it lowered the threshold at high frequencies. In other words, the intensity-frequency curves all cross one another over a relatively wide range of frequencies, so that at high frequencies a complete reversal of order is found as compared with the order at the lowest frequencies.

These results are in accord with data on direct electric sine-wave stimulation of nerve fibers, if it be assumed that adaptation to increasingly higher luminance results in increased electric excitability and in faster accommodation of the stimulated nerve fibers.

Nature of Bacitracin

Lyman C. Craig, W. Hausmann, J. R. Weisiger,
Rockefeller Institute for Medical Research

A little more than 10 years ago Johnson and Melaney noted the antibiotic effect of debrided tissue from the infected wound of a little girl named Tracy. Further study showed the active principle to be elaborated by a variant of *B. licheniformis*. The antibiotic was called bacitracin.

Countercurrent distribution studies at the Rockefeller Institute indicated bacitracin to be a mixture of several unusual polypeptides now called bacitracin A, B, C, and so forth. A, the one present in largest amount, has been shown to contain 12 amino-acid residues. The amino-acid residue formula is Phe · Leu · $(Ileu)_2$ · Cys · Orn · Lys · His · $(Asp)_2$ · Glu. Hydrolytic studies have further revealed the probable amino-acid sequence and the presence of several linkages involving the amino-acid residues that are unique in peptide chemistry. The antibiotic action therefore appears to stem from the unusual way the residues are joined rather than from the presence of a distinctive so-called "prosthetic" group.

Origin of Symptoms in Wilt Diseases of Plants

A. E. Dimond, Paul E. Waggoner, David Davis,
Connecticut Agricultural Experiment Station

Vascular wilt diseases display two conspicuous symptoms: discoloration of vascular bundles and wilting. The relationship between them has not been clear. Our data on *Fusarium* wilt of tomato suggest that vascular discoloration arises by a three-stage process. (i) Fungal pectin esterase and polygalacturonase hydrolyze the pectins cementing the host cells together, thus disorganizing them. (ii) Disorganized host cells are attacked by glucosidases that split polyphenols from phenolic glycosides. (iii) The polyphenols are oxidized to the discoloring melanoid pigments by terminal oxidases of the host. The pectic enzymes and the glucosidase can be found in *Fusarium* cultures and in the tracheal sap of diseased, but not of healthy, plants. A glucosidase alone, emulsin, causes no discoloration of tomato stems. Emulsin plus macerated cells discolor stems more than macerates alone. Polyphenols such as pyrogallol reproduce in tomato stems the vascular discoloration characteristic of tomato wilt.

Water moves as rapidly through pyrogallol discolored stems as through normal ones. In diseased stems, however, water moves at about 2 percent of the rate in healthy ones. Impeded water movement causes wilting and apparently results from plugs in stems and petioles, observable in fresh, but not in fixed, sections. Partial hydrolysis of host pectins by fungal enzymes or the resynthesis of hydrolytic products to gums seems likely to cause the plugs that impede water flow. Vascular discoloration is thus related to, but is not the cause of, decreased water flow.

Prediction of the Ionic Character of Chemical Bonds

B. P. Dailey, *Columbia University*

In theoretical chemistry, the reactivity and properties of a molecule are frequently discussed in terms of the ionic character of its chemical bonds. It has been suggested that this property of a chemical bond is related to the difference in electronegativity of the two atoms forming the bond.

The relationship recently obtained between the electronegativity difference of the two bonded atoms as a singly bonded diatomic molecule and the ionic character of the bond are discussed. This relationship is based primarily on the wide variety of nuclear quadrupole coupling constants derived from the data of microwave spectroscopy. Additional recent dipole moment data were also used to establish and verify this relationship. One of the points established by this approach is that bonds between atoms that differ in electronegativity by more than 2 units are almost completely ionic.

Unfortunately, it has not been possible previously to extend a relationship similar to the afore-mentioned one to chemical bonds in polyatomic molecules. The electronegativity of an atom changes when the atom forms more than one bond, and this change cannot be simply calculated. It has recently proved feasible to derive a table of the electron withdrawal power or electronegativity of functional groups such as SO_4 and OH from a study of so-called "chemical shifts" in the high-resolution nuclear magnetic resonance spectra of compounds containing these functional groups.

In particular the relative electronegativities of the functional groups have been derived from the shift in the value of the resonant magnetic field for protons in the methylene and methyl groups in molecules of the type C_2H_5X, where X is the functional group. The position of the methyl resonance was used as a fixed internal standard. The relationship between the chemical shifts and electronegativity was established using $H(C_2H_5)$ and Cl (C_2H_5Cl) as reference points.

Some Interesting Properties of the Enzyme Ascorbic Acid Oxidase

Charles R. Dawson, *Columbia University*

The experimental realization that trace amounts of certain metallic elements play fundamental roles in the life-processes of plants and animals has stimulated much interest in recent years. One result of this new interest has been a focusing of attention on the catalytic chemical processes of the living cell. Many of the catalytic agents of the cell, the enzymes, have been isolated and carefully examined for their metal content or metal requirements during function. Several enzymes, containing the metallic element copper as a vital feature of their protein structure and their function, have been found and investigated. In this group of copper-proteins, the enzyme

that catalyzes the direct aerobic oxidation of vitamin C, ascorbic acid oxidase, has been found to have most interesting properties in regard to its structure, color, catalytic function, and stability. New information concerning these features of the enzyme has been obtained from studies involving exchange reactions with radioactive copper.

Role of the Spinal Cord in the Induction and Structuring of the Vertebral Column

S. R. Detwiler, ***Columbia University College of Physicians and Surgeons***

Howard Holtzer, ***University of Pennsylvania***

Various surgical procedures upon the developing urodele embryo (Amblystoma) have shown a remarkable influence of the spinal cord upon the development and differentiation of the vertebral column (Holtzer and Detwiler, 1953, 1954). In the absence of the spinal cord, the mesodermic somites fail to differentiate chondroblasts, and vertebrae are entirely lacking.

When a supernumerary piece of embryonic spinal cord is grafted into the ventrolateral region of the mesodermic somites, the cells normally destined to differentiate into trunk musculature, transform into cartilage, and the grafted cord becomes girdled by a supernumerary axial skeleton. This induced system is histologically and morphologically identical to a normal axial system. The notochord plays no formative role in this process.

Excision of the medial portions of the mesodermic somites (presumptive sclerotome) is followed by the differentiation of normal neural cartilaginous arches that have become chondrified from presumptive muscle tissue under the inductive influence of the spinal cord.

The interpolation of somites between two halves of a longitudinally split spinal cord is followed by the differentiation of a pronounced band of muscle fibers. In addition, each of the two miniature spinal cords may become girdled by skeletogeneous material. These and other findings attest to a definite formative role of the embryonic spinal cord upon the terminal differentiation of the somites.

The essential findings in the urodele have been confirmed by grafting experiments upon chick embryos (Fowler and Waterson, 1953) and by experiments dealing with the differentiation of mouse somites *in vitro* (Holtzer and Grobstein, in press).

Studies on the Physical Chemistry of Imidazoles

John T. Edsall, Yasuhiko Nozaki, Frank R. N. Gurd, David Garfinkel, ***Harvard University***

Because of the importance of the imidazole group of histidine in the reactions of proteins, studies have been carried out on the Raman spectra of imidazole and 4-methyl imidazole and their hydrochlorides and on the binding of those imidazoles by the ions of zinc and cupric copper at different temperatures. Binding studies on imidazole itself have already been reported [J. T. Edsall *et al.*, *J. Am. Chem. Soc.* **76**, 3054 (1954)]. The 4-methyl imidazole shows affinities for the ions of copper and zinc very similar to those of imidazole itself. In all cases, it is found that 4 molecules of imidazole can be bound by either the copper or the zinc ion. The positive interactions between the successive binding constants are even more marked in 4-methyl imidazole than in imidazole itself. The first and last of the logarithmic intrinsic association constants for 4-methyl imidazole are (i) for copper at 29°, $\log \kappa_1 = 3.46$, $\log \kappa_4 = 2.48$; (ii) for zinc at 27°, $\log \kappa_1 = 1.85$, $\log \kappa_4 = 2.96$. Values for the intermediate binding constants will be presented later. All these association constants increase with decreasing temperature.

Raman spectra of the basic imidazoles and of their conjugate acids show far-reaching alterations in the spectrum associated with proton binding. These alterations presumably reflect changes in the character of the C—C and C—N bonds in the ring resulting from the acquisition of a positive charge on one of the ring nitrogens. Analogous studies, now being carried out on histidine derivatives, should furnish a basis for the spectroscopic detection of the ionization of imidazole groups in proteins.

Complex Ions and Electron Exchange

R. W. Dodson, ***Columbia University*** **and** ***Brookhaven National Laboratory***

Some results of a continuing investigation of the kinetics of electron-exchange reactions between different oxidation states of elements in aqueous solution are presented.

These reactions, like many nonequilibrium oxidation processes, are markedly affected by anions capable of forming complexes with the reactants. In most of the known cases the electron exchange is accelerated. In some cases, however, a strong inhibition is observed. It proves convenient to relate the kinetic effects to the equilibriums of complex formation.

The 2-electron transfer between thallous and thallic ions has been studied from this point of view in the presence of chloride and of cyanide. The 1-electron transfer between ferrous and ferric ions has been investigated in the presence of thiocyanate, bromide, and oxalate. The results are compared with earlier work on the thallium, iron, and other exchange systems, and, to the extent possible, with existing theory on the rates of electron transfer. Some rather striking relationships between the heats and entropies of activation in the different systems are found.

Work was performed with the support of the U.S. Atomic Energy Commission.

New Antimetabolic Compounds

Morris Engelman, Horace B. Gillespie, Kathe B. Liedke, Samuel Graff, ***Columbia University College of Physicians and Surgeons*** **and** ***Francis Delafield Hospital***

The synthesis of new benzimidazoles and benzotriazoles recently reported has been extended to include related quinoxaline and other derivatives. The structures are somewhat analogous to those of the purines and of 8-azaguanine, a carcinostatic agent. There is only presumptive evidence, however, that these compounds inhibit nucleic-acid metabolism. They appear not to interfere with respiration. The compounds exhibit antimetabolic activity on developing frog embryos. Amphibian embryos provide certain advantages for the study of antimetabolic activity, since they constitute closed systems that do not require nutriments from without. The embryos exhibit selective responses to the compounds according to developmental stage. Among the newer compounds 5-nitro-7-methoxy quinoxaline is perhaps significant, because it inhibits differentiation, rather than cell division, in *Rana pipiens*. The synthesis and biological effects of these compounds are discussed.

Application of Paramagnetic Resonance Spectroscopy to Chemical Problems

George K. Fraenkel, *Columbia University*

The new technique of paramagnetic resonance absorption spectroscopy has recently been employed to detect minute amounts of molecules which contain essentially free electron spins. An instrument has been developed that is capable of detecting about 2×10^{-11} moles of a representative organic compound containing one unpaired electron per molecule; we estimate that, under appropriate yet typical conditions, 5×10^{-14} moles should be detectable.

The properties of the biologically important semiquinones have been studied, and the paramagnetic spectrum of the unstable p-benzosemiquinone gives the first direct evidence for the existence of this radical in solution. Spectra of other more stable semiquinones have been observed, and structure is found in these spectra that is believed to result from interaction between the electron spin and the protons in the radicals; it is useful for identifying the radical species and for determining the location of an unpaired electron in a molecule.

Radicals have also been detected for the first time in quenched, and partially polymerized, vinyl polymers; a distinctive spectra is obtained that is related to the nature of the monomer used. Molten sulfur, well known to possess a transition region of high viscosity, has been shown to contain radicals, thus confirming the hypothesis that chain polymers are formed at the transition temperature. The strength of the sulfur-sulfur bond in a chain can be derived from measurements of the intensity of the paramagnetism. The excited state of certain types of thermochromic compounds has been shown to be paramagnetic, and the equilibrium constant for the transformation from the ground to the excited state can be evaluated.

Conductance of Strong Electrolytes at Finite Dilution

Raymond M. Fuoss and Lars Onsager, *Yale University*

Previous work on strong electrolytes, which considered the long-range effects of electrostatic forces proportional to the first power of the ionic charges, shows that the equivalent conductance of strong electrolytes approaches linearity in the square root of concentration c as the dilution approaches infinity. The experimentally observed conductance curves approach the limiting tangent from above; we (1932) attributed these positive deviations to indirect effects proportional to higher powers of the charges than the first. Our present computation includes terms that involve the squares of the charges.

An explicit conductance equation for electrolytes containing two species of ions results, when the improved relaxation equation is combined with the electrophoresis term given by Onsager and Fuoss. It describes the approach of the conductance curve to the limiting Debye-Hückel-Onsager tangent. The limiting behavior of the transcendental terms in the equation is like that of $c \log c$, but in the practical working range explicit functions of the form e^x Ei (x) must be used. The equation (which contains only two arbitrary parameters, limiting conductance and mean ionic radius) precisely reproduces Shedlovsky's conductance data for lithium, sodium, and potassium chlorides in water at 25°C up to at least 0.1 normal. Deviations between theoretical and observed curves for potassium and silver nitrate solutions clearly show that ion pair formation occurs in these salts. In addition to providing a theoretical treatment of strong (that is, unassociated) electrolytes at nonzero concentrations, the equation also provides an unambiguous criterion for establishing the occurrence of ion pair formation and should permit a much more realistic computation of association constants than has hitherto been possible.

Radiochemical Studies of Nuclear Reactions at Bev Energies

Gerhart Friedlander, *Brookhaven National Laboratory*

Determinations of the yields of radioactive end-products have been used for the study of interactions of complex nuclei with protons of 0.4 to 3.0 Bev kinetic energy. In the bombardment of both copper and lead targets with 2.2 Bev protons, products with 20 or more mass numbers below the target mass are formed with much higher cross sections than in similar bombardments with 300 to 400 Mev protons.

In the case of lead targets, even such low-mass nuclides F^{18}, Na^{24}, Mg^{28}, P^{32} are formed with cross sections of the order of 1 millibarn. In the yield-versus-mass curve of the products from lead bombardments, there is no pronounced peak that can be clearly associated with fission into two almost equal fragments. Measurements on recoil energies of certain products such as barium isotopes also show that these are not formed by a fission process as they are at lower bombarding energies. The excitation functions for a number of reactions such as the formation of the low-mass products from lead rise steeply with proton energy above about 0.5 Bev, whereas the cross sections for relatively simple reactions in heavy elements decrease with increasing proton energies.

The results may be interpreted to indicate that very large energy transfers (upward of hundreds of Mev) to the struck nuclei are quite probable with bombarding energies in the Bev region. Some characteristic reactions, particularly the formation of some alpha-emitting rare-earth activities in heavy element targets, are useful as monitors for high-energy beams.

Research was performed under the auspices of the U.S. Atomic Energy Commission.

Numerology of Polypeptide Chains

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N. Metropolis, *Los Alamos Scientific Laboratory*

It seems very likely that the specificity of proteins is determined by the particular order of amino acids in long polypeptide chains. It has been suggested that this sequence in its turn reflects the order of purine and pyrimidine bases in the long polynucleotide chains of DNA or RNA. If this is true, there must exist a unique coding procedure that permits one to translate long sequences formed by four different elements (bases) into equally long sequences formed by about 20 different elements (amino acids). Since the number of all possible sequences of the second kind exceeds by a very large factor the corresponding number for the sequences of the first kind, the code in question must be extremely restrictive and must lead to strong intersymbol correlation between the neighboring amino acids in known protein sequences.

One way to compare different possible codes proposed

so far is to study statistically the dependence between the frequency of occurrence of different amino acids and the number of different neighbors that they possess in natural sequences and in the artificial sequences built up according to various proposed coding procedures. This is done by using the so-called Monte Carlo method on the Los Alamos electronic computer (Maniac) in which a large number of random sequences formed by four different elements are translated according to the various coding procedures into corresponding sequences of 20 different elements and the results are analyzed statistically. Observed and artificially constructed sequences are compared by means of graphs.

Behavior of Neutral Fields under Charge Conjugation

M. Gell-Mann, ***Columbia University*** **and** ***University of Chicago***

A. Pais, ***Institute for Advanced Study***

Certain familiar neutral particles, like the photon and π^0-meson, have the property that the operation of charge conjugation turns them into themselves. Other neutral particles, like the neutron, are supposed to behave differently; charge conjugation is supposed to transform the neutron N and antineutron $\overline{N}$ into each other, while the process $N \longleftrightarrow \overline{N}$ is to be rigorously forbidden by the law of conservation of heavy particles.

A third type of behavior is possible, in principle, for neutral fields, whether bosons or fermions. The particle p and its charge conjugate $\overline{p}$ may be distinct, but with the process $p \longleftrightarrow \overline{p}$ merely weak rather than rigorously forbidden. Under these circumstances, it is useful to consider a change of representation. If p is represented by a field χ and $\overline{p}$ by the charge conjugate field $\overline{\chi}$, one may introduce the fields $\chi_1 = \frac{\chi + \overline{\chi}}{\sqrt{2}}$ and $\chi_2 = \frac{\chi - \overline{\chi}}{\sqrt{2}i}$ and corresponding "particles" p_1 and p_2.

Now it has been suggested (*1–3*) that the θ^0-meson, a neutral boson, may belong to the third class, and furthermore that as far as production mechanisms are concerned, θ^0 and $\overline{\theta}^0$ behave quite differently. In the decay of these particles, however, it would be θ_1^0 and θ_2^0 that have different characteristics. In fact, if one of these latter can decay into 2 pions then the other cannot. Some consequences of this situation are discussed.

It is conceivable that the neutrino also belongs to the third class. Some arguments relevant to this question are given.

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Luminosity Curves for Normal and Dichromatic Subjects Including a Case of Unilateral Color Blindness

C. H. Graham and Yun Hsia, ***Columbia University***

During the recent past we have studied the luminosity functions of three groups of subjects, made up, respectively, of: (i) seven normal individuals, (ii) five protanopes (red-blind persons), and (iii) five deuteranopes (green-blind individuals).

In normal subjects, the luminosity curves for cone threshold show a maximum near 550 mμ, and "humps" appear in the red and the blue. These findings are in line with some results obtained by other investigators.

The data on the protanopes show the expected lowering of luminosity on the long wavelength end of the spectrum. As a result, the hump at 610 mμ is practically obliterated. Throughout the rest of the spectral range the sensitivity of the protanope is about the same as that for the normal.

In the case of the deuteranopes, it can be shown that the luminosity curve exhibits reduced sensitivities in the wavelength range between 530 mμ and 415 mμ.

A young woman gave typically deuteranopic discriminations with her left eye on our tests and normal discriminations with her right eye. The luminosity curves obtained on the two eyes differ in absolute sensitivity values in the blue and green regions of the spectrum; the sensitivity of the normal eye in these regions is considerably greater than the sensitivity of the deuteranopic eye. In the red end of the spectrum both eyes have the same sensitivity. The data on this subject are in line with the group results: deuteranopes show a loss of sensitivity in the green and blue as contrasted with normal individuals.

The relationship of the findings to the character of fundamental response curves is considered. The research was supported by a contract between the Office of Naval Research and Columbia University.

Molecular Microwave Oscillator and High-Resolution Spectrometer

J. P. Gordon, T. C. Wang, H. J. Zeiger, C. H. Townes, ***Columbia University***

An experimental device has been developed that can be used as a very high resolution microwave spectrometer, a microwave amplifier, or a very stable oscillator. It utilizes a beam of molecules, electrostatic focusing of certain states of these molecules, and a cavity in which radiation can occur and be detected. As a spectrometer, the device allows considerable reduction in Doppler width and has made visible new hyperfine structure in the spectrum of NH_3, which is discussed.

The apparatus involves amplification of microwaves as a result of interaction between radiation and the beam of molecules. As an amplifier, it has a very narrow band width and can give a particularly low noise figure. Sustained oscillations, powered by induced emission from the molecules, may be produced when the beam of molecules is sufficiently intense. The behavior of such an oscillator and its possible use as a frequency standard are discussed.

Intermolecular Forces and Induced Infrared Absorption

Ralph S. Halford, ***Columbia University***

The intrinsic spectral absorbances of molecular vibrations are modified by intermolecular perturbations when the molecules enter into condensed phases. The induced absorbance can be observed separately for each different mode of vibration to provide a substantial fund of information concerning molecular interactions involving a single molecular species. This information can be presented, item by item, in terms of an induced motion superimposed upon the intrinsic molecular one and thereby can be related in principle, through Newtonian laws of motion, to intermolecular forces. A single molecular species will yield a multiplicity of such relationships, the ultimate number being limited only by the number of its modes of vibration (including combinations and overtones as well as fundamentals) that can be excited spectroscopically.

The program of investigations is still in its preliminary stages, but findings to date are summarized for several systems including, among others, liquid and solid benzene, solid naphthalene, and a number of binary liquid solutions. Some tentative, qualitative generalizations are indicated.

Spatial Summation of Inhibitory Influences in the Eye of *Limulus*

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Rockefeller Institute for Medical Research

The discharge of impulses in a single optic nerve fiber from the eye of *Limulus*, in response to illumination of the receptor element from which it arises, is slowed by illuminating receptors in nearby regions of the eye. This inhibition is greater the higher the intensity of illumination on the nearby region and the closer this region is to the receptor under observation. It is also greater the larger the area illuminated; spatial summation of inhibitory influences thus occurs in this eye. This summation presumably takes place over the plexus of nerve fibers that underlies the receptors.

The receptors that inhibit an active receptor element in their vicinity are themselves subject to mutual inhibitory interactions, which reduce the total effect that they exert. For example (i) two small areas of given inhibitory effectiveness may together produce a smaller summed effect when they are close to each other than when they are far enough apart to exert little inhibition upon each other; (ii) a region that is too far from the receptor under observation to exert a direct effect upon it may actually release it, partially, from the inhibition caused by a nearer region, by inhibiting the activity of receptors in that region. Thus the resultant inhibition of a receptor depends on the spatial distribution of light on receptors in regions of the eye surrounding it.

Similar interactions may be significant in visual systems of other animals and probably play an important role in the mechanism of visual contrast.

Studies on Animal Virus Reproduction

Frank L. Horsfall, Jr.,
Rockefeller Institute for Medical Research

Influenza A and B virus particles can be enumerated by determining the number of erythrocytes they cause to sediment at an increased rate. Because one infective particle can initiate reproduction in susceptible cells, the ratio of infective to total particles can be found by determining the smallest number of particles that can infect.

The number of cells lining the allantoic sac of the chick embryo has been shown to be 1.8×10^7. When less than one particle per cell of influenza A or B virus is inoculated, about 6×10^{10} new particles are produced. If all cells support virus reproduction, the yield per cell is approximately 3×10^3 particles.

With inocula of less than one particle per cell all the new particles of either virus are infective and the logarithmic rate of production is constant until the number of particles reaches about 90 per cell. Then the rate diminishes sharply with increasing time, and noninfective particles accumulate rapidly. The time to double the number of particles is 46 min with influenza A, 60 min with influenza B virus. Both viruses lose infectivity at a rapid rate. In allantoic fluid at 35°C the half-life of infective particles is 147 min for influenza A, 85 min for influenza B virus. Thus the ratios between generation time and half-life are as high as 0.31 and 0.71, respectively.

Infective or noninfective particles of either virus in amounts greater than two per cell alter the reproductive process in three ways: (i) The interval before new particles appear is increased. (ii) The logarithmic rate of production is decreased. (iii) The proportion of new particles that are infective is markedly diminished in direct relation to the initial particle-cell ratio.

In contrast, infective Newcastle disease virus has a half-life greater than 14 hr at 35°C and a generation time of 43 min. Thus the generation time-half-life ratio is less than 0.05. The yield per cell is about 1×10^3 particles. Unlike influenza, Newcastle disease virus in amounts greater than two particles per cell does not alter the reproductive process. Regardless of the particle-cell ratio, all new particles produced are infective.

Effect of Chemicals on Sporulation of Fungi

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Connecticut Agricultural Experiment Station

The process of asexual sporulation in fungi is only vaguely understood. It necessitates cell division and a new cell wall that is distinct so that the spore can be pinched off. It requires extra energy above that needed for vegetation. Sporulation is induced by an optimum energy level that varies among fungi. Metals are known to augment sporulation. The following classes of compounds generally reduced sporulation of *Monilinia fructicola* in pure culture on agar: chelating reagents, ketones, thiones, amines, phenols, hydrocarbons, and chlorinated hydrocarbons. The effect of ketones and thiones is quenched by a basic nitrogen group nearby on the molecule, and vice versa. α, β-Unsaturation of a ketone usually enhances biological activity. Here it seems to quench activity.

We suggest that chelating agents bind metals that participate in energy-giving oxidative reactions, that ketones and thiones lift the redox potential above the optimum for sporulation and the amines push the potential below the optimum, that they cancel each other when present on the same molecule, that mitosis is discouraged (i) by reaction of the ketones, thiones, amines, and phenols with the proteins of the chromosomes, and (ii) by interference with spindle-fiber formation by hydrocarbons and chlorinated hydrocarbons. We suggest further that fission of bacteria and sporulation of fungi may be biochemically related, because metal starvation, phenols, and certain amino compounds are known to retard fission of certain bacteria.

Components of the Specific Polysaccharides of Types IX, XII, and XIV Pneumococcus

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S. A. Barker and Maurice Stacey,
University of Birmingham, England

Because numerous polyglucoses give precipitates in type IX and type XII antipneumococcus serums and several galactans precipitate type-XIV antiserum, it appeared desirable to investigate the sugars contained in the type-specific capsular antigens of types IX and XII pneumococcus and to learn more of the structure of type-XIV polysaccharide. The first two substances contained glucose, as might have been expected from the aforementioned cross reactivity. By paper chromatography glucuronic acid, glu-

cosamine, and another basic sugar or disaccharide were also tentatively indicated in the type-IX substance, as well as ribose, probably due to accompanying nucleic acid. The infrared spectrum showed broad absorption around 850 cm^{-1}, indicating α-linkages. The type-XII polysaccharide contained glucose and galactose, as indicated chromatographically, with a smaller quantity of hexosamine, probably N-acetylated, since the infrared spectrum showed absorption peaks at 1644 and 1560 cm^{-1}.

The type-XIV substance, hitherto believed to contain only galactose and N-acetylglucosamine, both of which also occur in the cross-reacting blood group substances, was found to be more complex. Chromatographic and ionophoretic tests showed that glucose and glutamic acid appeared on vigorous hydrolysis. These were possibly derived from products with the mobilities of di- and oligosaccharides which were evident on milder hydrolysis. In the infrared spectrum absence of absorption around 840 cm^{-1} and the presence of a peak at 890 cm^{-1} indicated that the majority of the linkages were of the β-type.

Relationship of Wound Sap to the Formation of Crown-Gall Tumor Cells

Richard M. Klein, ***New York Botanical Garden***

Tap roots of carrots differ in their ability to form crown-gall tumor cells independent of the strain of virulent crown-gall bacteria used in the quantitative assays. The tumorous alteration of the cells is a function of their cell and tissue type and of their position in the root. It is also affected by the juices expressed from the various tissue areas. This wound sap is involved in the activation or conditioning of normal plant cells and in the synthesis, by crown-gall bacteria, of a tumor-inducing principle that alters conditioned cells into incipient tumor cells. The bacterial synthesis of tumor-inducing principle has been demonstrated *in vitro*.

Venezuelan Guayana—a Long-Known but Little-Understood Region

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Belief by Spanish explorers and adventurers of the mid-16th century in the legend of the fabulous and gold-rich city of Manoa in the interior of Venezuelan Guiana led to a burst of interest in the region, culminating in Sir Walter Raleigh's ill-fated attempt to discover El Dorado. Major errors in the concept of the geography of the region at that time are briefly outlined. Not until Alexander von Humboldt's travels in the beginning of the 19th century was there a scientific evaluation of some of the geographic realities. During the past 20 years, the efforts of the Venezuelan Government and such individuals as the explorer, Felix Cardona, and the ornithologists, William H. Phelps and William H. Phelps, Jr., as well as the advent of air photography, have given an impetus to our understanding of the region, many parts of which still remain virtually unknown.

Cartographically it has been one of the most puzzling areas in South America. The American Geographical Society, in its program for preparing a uniform map of the Americas south of the Rio Grande on the scale of 1: 1,000,000 was thrice forced to recompile Guiana before publishing because of new and conflicting information. It prepared a reconnaissance map of 16,000 mi^2 from air photographs in New York in connection with one of Phelps' ornithological expeditions, thus providing the map from which scientific exploration of the virtually unknown could be planned beforehand.

Of particular interest are those isolated mountains rising into the subtropical zone, for there extreme endemism is exhibited by both plants and birds. The nature and origin of the mountains, remnants of a once widespread sandstone formation, is discussed briefly.

Purification of Human Antidextran

Elvin A. Kabat, ***Columbia University College of Physicians and Surgeons*** **and** ***Presbyterian Hospital***

Antibody to dextran has been produced in human beings by the injection of small quantities of dextran. These antibodies, as formed in most individuals, have specific combining sites with dimensions complementary to terminal nonreducing chains averaging at least three and probably four 1 → 6 anhydroglucopyranose units.

Using dextran NRRL B512 containing 96 percent 1 → 6 and 4 percent 1 → 3 like units as established by periodate oxidation [J. C. Rankin and A. Jeanes, *J. Am. Chem. Soc.* 76, 4435 (1954)], the antidextran is precipitated and washed with saline to remove extraneous serum protein, the specific precipitate is suspended in acetate buffer at *p*H 5.1 and a small quantity of dextranase from *P. funiculosum* [kindly supplied by E. J. Hehre; see H. M. Tsuchiya *et al.*, *J. Bact.* 64, 513 (1952)] is added. On warming at 37°C for 1 hr the precipitate goes almost completely into solution as a consequence of the digestion of the dextran. The resulting oligosaccharides are dialyzed out, and a small amount of insoluble material is removed, giving the final antibody solution.

Antibody solutions contained about 90 to 95 percent of the nitrogen in the original specific precipitate, 80 to 90 per cent of which was reprecipitable by dextran. The human antidextran showed a single homogeneous boundary in the ultracentrifuge of sedimentation constant of about 7.0. Availability of purified antibody to an antigen composed of only a single sugar constituent together with the already described homologous oligosaccharides makes possible direct physiochemical measurements on the nature of oligosaccharide antibody complexes.

These studies were carried out under the William J. Matheson Commission and the Office of Naval Research [contract Nonr 266 (13)], Navy Department, Washington, D.C.

General Mechanisms for Enzyme Action

Daniel E. Koshland, Jr., ***Brookhaven National Laboratory***

A wide variety of enzymatic reactions that perform diverse biological functions and present apparently dissimilar chemical reactions, nevertheless, conform to the stoichiometry $BX + Y \rightarrow BY + X$. Included in this group are the phosphatases, phosphorylases, esterases, lipases, proteases, glycosidases, branching enzymes, and so forth. It is postulated that this large group of enzymes acts catalytically through a few basic mechanisms. These have been named the single-displacement mechanism, the front-side-displacement mechanism, and the double-displacement mechanism. The first two of these require that both substrates be present simultaneously on the enzyme surface, whereas the latter allows a primary electron-sharing attack by the enzyme on one substrate (BX) even in the absence of the second substrate. The fundamental charac-

teristic of all of these mechanisms is that they proceed by steps in which a single bond is broken as a single bond is formed in direct analogy to the well-known displacement mechanisms of organic chemistry.

With these assumptions it is possible to explain many observed phenomena such as the stereochemistry of the enzymatic reactions, the correlation of bond breaking with specificity, the occurrence or absence of exchange between BX and radioactive X, the simultaneous transferase and hydrolytic properties of some enzymes, and a rough explanation of the pH dependence of enzymatic activity. Specific illustrations have been obtained with 5′ nucleotidase, beta-glucosidase, acetylcholinesterase, invertase, the phosphorylases, and glutamine synthetase.

Research carried out under the auspices of the U.S. Atomic Energy Commission.

Measurement of Variability in Species of Fossil Invertebrates

John Imbrie, *Columbia University*

The coefficient of variation (V) has been widely employed as an objective measure of variability. If samples are reasonably homogeneous with respect to age, sex, environment, stratigraphic position, and locality, this procedure is normally justified. It frequently happens, however, that individuals in a collection of fossil invertebrates vary widely in age and that criterions are lacking to distinguish age groups. In these circumstances the form of the size-frequency distribution of any linear measurement is determined primarily by geologic factors extrinsic to the organisms, and V is unrelated to biological variability. This difficulty can be largely avoided by considering pairs of logically related linear measurements and defining variability in terms of the dispersion of values about the curve of relative growth calculated by standard regression methods.

Using the standard error of estimate as a measure of absolute dispersion, a coefficient of relative dispersion analogous to V can be obtained. The use of this measure has been justified empirically by Klauber on populations of modern rattlesnakes and by the present author on populations of modern and fossil brachiopods.

Velocity Distribution Measurements in Atomic and Molecular Beams

P. Kusch and R. C. Miller, *Columbia University*

A high-resolution spiral rotor velocity selector has been built for study of the velocity distribution of the particles in atomic and molecular beams. For atoms effluent from an oven with slits designed to approximate as nearly as possible an ideal aperture of infinitesimal thickness, it is found that the velocity distribution is that to be expected from a Maxwellian velocity distribution within the oven. In the case of the alkali halides the velocity distribution indicates the presence of polymers of the diatomic molecule. The polymers are principally dimers and are an important component of the lithium halides. They decrease in abundance, under our experimental conditions, with increasing atomic number of the alkali and are unobservable for the cesium halides. An observation of the abundance of the dimers as the temperature and pressure of the gas in the oven are varied yields the heat of dissociation of the dimeric molecule into two monomeric molecules.

Rate of Evaporation of Water through Monolayers of Fatty Acids

Victor K. LaMer and Robert J. Archer, *Columbia University*

The control of evaporation from reservoirs is a problem of economic importance. The influence of monolayers has been investigated by measuring the rate of absorption of water vapor by a desiccant surface 2 mm above the water surface. The rate of evaporation is reduced by a factor of 10^4 by these monolayers. The data are reported as specific resistances of the monolayers to evaporation for the saturated fatty acids, C_{17}, C_{18}, C_{19}, and C_{20}. They were measured as a function of surface pressure, chain length, monolayer phase, subphase composition, and temperature.

For a liquid condensed phase, the logarithm of the resistance of a monolayer is independent of the surface pressure and pH of the subphase but is a linear function of the chain length and the reciprocal of absolute temperature, which substantiates the description in terms of an exponential energy barrier.

A theory is proposed for the source of the energy barrier; calculation of its magnitude agrees well with known data on heats of vaporization. A full discussion will appear in the *Journal of Physical Chemistry*.

Temporal and Intensity Limits of the Flicker-Fusion Threshold

Carney Landis, *Columbia University*

When the eye is stimulated by intermittent light, any of several sensory experiences may result. The experience of flicker may change to fusion, or vice versa; that is, a critical flicker-fusion threshold (CFF) may be established. The basic considerations are successive pulses of light having measurable duration; the pulses are separated by measurable intervals of reduced light or absence of light. In most experiments the duration of the light pulse and darker interval bear some regular relationship to each other, which usually has been expressed as a light-dark ratio. It is of interest to consider the boundaries in time and luminance within which the CFF has been found to occur. The luminance limits are approximately -6.67 log millilamberts to 5.5 log millilamberts. The pulse duration limits extend from 8×10^{-6} to 2.5×10^{6} μ sec. The darker interval duration limits extend from 0.6 to 2.5×10^{6} μ sec. A three-dimensional graphic representaion of these boundaries which gives rise to a "solid" is shown. Within these boundaries the interaction of the effects of the ten or more known determinants of the CFF may be systematically located and their effect on the temporal and luminance components may be apportioned.

Model for Multiple Meson Production

T. D. Lee, *Columbia University*

A Bloch-Nordsieck type treatment of multiple meson production is presented. In this treatment the physical nucleon is regarded as a composite system composed of a core surrounded by a meson cloud. The collision of two nucleons is assumed to consist of a sudden exchange of spin, isotopic spin, and momentum between the cores of these two nucleons; these, in turn, shake off part of the surrounding mesons as radiation. This treatment is applied to both the symmetrical scalar meson theory and the neutral pseudoscalar theory for arbitrary values of the coupling constant.

Uranium-Lead Method of Age Determination

J. Laurence Kulp, ***Columbia University***

The absolute geologic time scale has been inferred from age measurements by the uranium-lead method. New investigations have elucidated the factors that produce anomalies among the various isotopic ratios that are used for the age measurement in this method, that is

$$\frac{Pb^{206}}{U^{238}},\ \frac{Pb^{206}}{Pb^{210}},\ \frac{Pb^{207}}{U^{235}},\ \frac{Pb^{207}}{Pb^{206}},\ \text{and}\ \frac{Pb^{208}}{Th^{232}}.$$

Correction for common lead contamination is improved if the isotopic composition of the common lead of a district is known. Radon leakage occurs in all radioactive minerals, but this phenomenon can be measured and its effect calculated. Leaching of lead in preference to uranium also appears to occur under certain conditions. The agreement in the isotopic and chemical assays from various laboratories suggests that the analytic procedures are not a significant source of error.

An attempt is made to illustrate each of these effects with new data, to show which age determinations can be accepted with a high degree of confidence, and to propose the experimental program required to fill out the geologic calendar.

Alternate Modes of Pion and Muon Decay and of Muon Capture

S. Lokanathan, J. Steinberger, H. Wolfe,
Columbia University

We have searched for the following three processes:

$$1)\ \pi^+ \rightarrow e^+ + \nu$$
$$2)\ \mu^+ \rightarrow e^+ + \gamma$$
$$3)\ \mu^- + Cd \rightarrow Cd^* + e^-$$

The apparatus employed electronic counting techniques and was of considerably greater sensitivity than has previously been used for this purpose. Nevertheless, we have found no evidence for the existence of these reactions and find

1) Rate $(\pi^+ \rightarrow e^+ + \nu)$/rate $(\pi^+ \rightarrow \mu^+ + \nu) < 5 \times 10^{-6}$
2) Rate $(\mu^+ \rightarrow e^+ + \gamma)$/rate $(\mu^+ \rightarrow e^+ + 2\nu) < 2 \times 10^{-5}$
3) Rate $(\mu^- + Cd \rightarrow Cd^* + e^-)$/rate $(\mu^- + Cd \rightarrow Ag^* + \nu) < 3 \times 10^{-3}$.

Present theory does not seem to provide an understanding of the smallness of these interactions compared with those that are actually observed.

Cytochemistry of the Human Ovary

Margaret E. Long and Earl T. Engle,
Columbia University College of Physicians and Surgeons

Ovarian histophysiological studies have long centered their interest on the identification of the cells that secrete ovarian hormones or related substances. Most of the enlightenment on this subject has been obtained from studies of animal ovaries. This paper presents a cytochemical analysis of preovulatory follicles in sections of resected human ovaries.

Since ovarian hormones are fat-soluble steroids, lipid tests were correlated to identify the types of lipid and their distribution throughout normal follicular development and atresia. Reactive lipid substances, mainly cholesterol, were visualized in theca interna cells of healthy preovulatory follicles. The granulosa of normal follicles contained no lipid. Nonspecific lipid was first localized in theca cells of preantrum-stage follicles; cholesterol in the succeeding early antrum stage. Granulosa lipid, acidic or phospholipid in nature, appeared in atretic follicles of all types. The theca interna then, presumably, is the site of the production of ovarian hormones or of precursor substances.

Using the PAS technique, glycoprotein was inferred as a component of the follicular fluid, the zona pellucida, and the basement membrane. The zona pellucida was thus demonstrated as a thin membrane in the primary follicle. The earliest manifestation of the secretion of follicular fluid was in the four-layered follicle.

Vitamin B_{12}, Rhizobia, and Leguminous Plants

Alfred P. Levin, Helen B. Funk, Moses D. Tendler,
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Assays of *in vitro* cultures of root-nodule bacteria with *Euglena gracilis* var. *bacillaris* and with *Ochromonas malhamensis* confirmed that *Rhizobium meliloti*, *R. trifolii*, and *R. leguminosarum* synthesize vitamin B_{12}, as had been shown previously. Additional studies showed that the ratio of the amount of the vitamin excreted to that retained with the cells of *R. meliloti* was at least 1:2; of *R. trifolii*, at least 3:1; and of *R. leguminosarum*, at least 1:1.

Assays of the pink (leghemoglobin-bearing) root nodules of alfalfa, clover, and pea plants revealed the concentration of vitamin B_{12} to be 3 to 34 times greater than that in the root tissues. In the case of alfalfa, the concentration of the vitamin in pink nodules was 400 percent greater than in white nodules.

Rhizobia isolated from pink nodules gave a different ratio of vitamin excreted to retained as compared with those for the bacterial cells grown *in vitro*. The *in vivo* ratios were for *R. meliloti*, 14:1, and for *R. trifolii*, 5:1. There was also an increase in the number of molecules of vitamin B_{12} synthesized per bacterial cell in the nodules, this being especially marked for *R. trifolii*.

Botanical Exploration of the Guyana Highland

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New York Botanical Garden

For 250 years naturalists have been lured to the Guyana Highland of northeastern South America by the great riches of plant and animal life that are to be found there. The sandstone table mountains that form the characteristic topographic feature of the region bear on their summits a flora that contains the highest incidence of endemism known from any part of the globe of like area. The Guyana Highland extends from near the Colombian boundary across southern Venezuela and British Guiana to Surinam.

The New York Botanical Garden has been actively exploring this region since 1944. Sixteen expeditions have been made by the Garden thus far, with four more now in progress. Some 18,000 numbers of plant collections have been made in sets of 6 to 10 each and by the end of the current season, which draws this exploratory phase of the Garden's work in the Guyana Highland to a close, aproximately 150,000 specimens will have been taken. It is estimated that the area in all contains some 4000 to 5000 endemic species and 100 new genera, large numbers of which are as yet undescribed.

Effect of Some Iron Complexes on Hydrogenase

Alvin Krasna and David Rittenberg,
Columbia University College of Physicians and Surgeons

We have previously shown that the enzyme hydrogenase is inhibited by very low concentrations of nitric oxide [*Proc. Natl. Acad. Sci.* 40, 225 (1954)]. In a search for other inhibitors, we have tested the effect of nitroprusside and several other pentacyano and hexacyano iron complexes on the hydrogenase of *Proteus vulgaris*. The enzyme activity was measured by determining its catalytic effect on the rate either of the orthopara hydrogen conversion or of the exchange reaction between HDO and H_2 [*J. Am. Chem. Soc.* 76, 3015 (1954)]. The following ions at a concentration of 10^{-2} molar had no inhibitory effect; ferrous, ferric, ferricyanide and ferrocyanide. Six pentacyano iron compounds, tested at 10^{-4} molar concentration inhibited hydrogenase about 50 percent. In a particular compound, nitroprusside inhibits 69 percent at $10^{-4}M$, 56 percent at $10^{-5}M$, and 46 percent at $10^{-6}M$.

During the experiments in which nitroprusside was tested for its inhibitory effect, it was observed that the solution of nitroprusside changed from its original faint orange to blue-green and finally to a yellowish-brown. Quantitative determinations show that 1 mole of hydrogen was consumed per mole of nitroprusside.

The blue compound formed after partial reduction is bleached by air to yield a compound other than nitroprusside. Nitroprusside is not reduced by hydrogen activated by platinum.

Interaction of High-Energy Nucleons with Complex Nuclei

J. M. Miller, *Columbia University*

The cross sections for the formation of various radioactive products that result from the inelastic interaction of protons in the 0.2- to 3-Bev energy range with complex nuclei indicate that, although the mechanism of compound nucleus formation advanced by Bohr (*1*) in the discussion of nuclear reactions induced by low-energy particles (below 50 Mev) certainly does not apply, nevertheless, at least part of the energy transferred during an inelastic collision in the higher energy range is statistically distributed among the nucleons in the nucleus: the observed distribution of products may be considered as the result of the "evaporation" (*2*) of particles from excited nuclei. This idea is useful for the estimation of the unmeasured cross sections for the formation of stable products.

If it is assumed that essentially all the nucleons lost from a struck nucleus are emitted by the "evaporation" mechanism, then the probability that a given quantity of energy is transferred during an inelastic interaction may be estimated from the experimental data (*3*). The application of this rather extreme assumption to the interpretation of some experiments carried out with protons in the Bev energy range yields internally consistent results for the probability function. This excitation-energy distribution function, in turn, is related to the problem of the interaction of high-energy nucleons with nucleons bound in the target nucleus.

The nonvanishing probability for rather large energy transfers calculated under this assumption from the results with Bev protons is qualitatively consistent with the observed increase in the free-nucleon interaction cross section in the Bev region over that in the 0.5 Bev region, and with the relatively copious meson production at the higher energy (*4*).

This work was partially supported by the U.S. Atomic Energy Commission.

References and notes: (1) N. Bohr, *Nature* 137, 344 (1936). (2) V. F. Weisskopf, *Phys. Rev.* 52, 295 (1937). (3) K. J. LeCouteur, *Proc. Phys. Soc.* A65, 718 (1952). (4) A. M. Shapiro, C. P. Leavitt, and F. F. Chen, personal communication.

Changes in Three-Dimensional Shapes of Cells, within the Apical Meristem, during Cell Division

Edwin B. Matzke, *Columbia University*

Cells in tissues have some features in common with the units of certain inorganic systems; they differ, however, in their origin from preexisting cells. In the present study, 400 interphase cells and 400 dividing cells were investigated. Median sections of the stem tip of *Anacharis densa* cut at 40 μ and stained in Feulgen and ruthenium red were used, and the cells were examined, in toto, under oil immersion.

The 400 interphase cells had an average of 13.9 ± 0.1 faces, the range being from 9 to 21. There were 101 cells with 14 faces; 13- and 15-faceted cells were also abundant. Hexagonal, pentagonal, and quadrilateral faces were most frequent. These 400 cells occurred in 96 combinations of faces; 38 cells had 4 quadrilateral, 4 pentagonal, and 6 hexagonal faces—the commonest combination—while four had 6 quadrilateral and 8 hexagonal faces, as in Kelvin's tetrakaidecahedra.

The 400 dividing cells averaged 16.8 ± 0.1 faces, the range extending from 13 to 22. In these cells there were 170 combinations of faces, and pentagonal faces were the most numerous. Cells in early prophase had an average of 16.4 ± 0.2 faces; in late prophase, of 16.7 ± 0.3 faces: in metaphase, of 16.8 ± 0.2; in anaphase, of 16.7 ± 0.3; in late telophase, of 17.1 ± 0.1 faces. In 150 daughter cells the number of contacts decreased to 12.6 ± 0.1.

It may be concluded that cells in interphase within the apical meristem have an average of close to 14 faces, that either prior to or in early prophase this average increases decidedly, that it continues to rise slightly during subsequent stages of division, and that new daughter cells average between 12 and 13 faces. The number of combinations of faces in both interphase and dividing cells is large, and no one configurational type predominates.

Studies on Ground Substances of Connective Tissue

Karl Meyer, Eugene A. Davidson, Alfred Linker, Philip Hoffman, *Columbia University College of Physicians and Surgeons* and *Presbyterian Hospital*

Acid mucopolysaccharides occur in mammalian connective tissues in complex and typical patterns. Two of these polysaccharides are nonsulfated: hyaluronic acid and the recently isolated chondroitin. Four mucopolysaccharides are sulfated: chondroitin sulfate A, B, and C and the recently described kerato-sulfate. Hyaluronic acid and chondroitin, aside from the nature of the hexosamines, probably have very similar structures. Both form highly viscous solutions, the hexosaminidic bonds of both are hydrolyzed by testicular and bacterial hyaluronidases at comparable rates, and bacterial hyaluronidases yield from

both polysaccharides hitherto unknown uronides unsaturated in the 4–5 position.

The deacetylated repeating disaccharide of chondroitin was isolated and crystallized. Its infrared spectrum was identical with that of chondrosine isolated from chondroitin sulfate A of cartilage and of C from umbilical cord. Chondroitin presumably is one of the sulfate acceptors of connective tissues. Studies on chondroitin sulfate B, obtained from skin, heart valves, tendon, and large blood vessels, have shown it to be markedly different from chondroitin sulfate A or C. B has a lower solubility and higher rotation than either A or C and is resistant to testicular hyaluronidase. It is hydrolyzed by acid at a rate markedly faster than A or C. It yields on decarboxylation 1 mole of CO_2 per hexosamine unit, whereas the carbazole reaction for uronic acid, which is normal for A or C, gives only half of the expected value. It yields a disaccharide with an infrared spectrum different from that of chondrosin. The neutral methyl esters of the sulfated polysaccharides have been prepared and structural studies including the reductive elimination of the sulfate groups for purposes of identification of its position are in progress.

Model Seismology Studies

Frank Press, Jack Oliver, Maurice Ewing,
Columbia University

Many problems in various branches of seismology may be investigated through the use of acoustical pulses of ultrasonic frequencies propagating in small-scale two-dimensional models. Specific examples include refracted waves in layers of finite thickness, air-coupled waves, compressional waves diffracted around the earth's core, and multiple arrivals from relatively simple configurations. The instrument may also be used as an analog computer to shorten the time required for numerical computations of lengthy and complex surface wave equations.

DNA in Diploid and Haploid Hybrid Frog Embryos

Betty C. Moore, ***Columbia University***

After the Feulgen reaction, microspectrophotometric measurements have been made of the nuclear DNA of the early embryos of diploid and androgenetic *Rana pipiens* and of diploid and androgenetical lethal hybrids between *R. pipiens* ♀ × *R. sylvatica* ♂. The large, weakly Feulgen nuclei of the early blastula of *pipiens* ♀ × *sylvatica* ♂ have DNA values similar to those found in the smaller, darker-staining nuclei of the late blastula. These values vary from diploid to tetraploid amounts of DNA. Early androgenetic hybrid blastulas of *pipiens* ♀ × *sylvatica* ♂ were found to have nuclear DNA values similar to those found in late androgenetic hybrid blastulas. These values vary from haploid to diploid amounts of DNA. Late-blastula nuclei of diploid *pipiens* have DNA values similar to those of the late-blastula nuclei of the diploid hybrids. Late-blastula nuclei of the haploid *pipiens* embryos have DNA values similar to those of the late-blastula nuclei of the haploid hybrids. Thus no change in the nuclear content of DNA has been found during the formation of the blastula in either the diploid or haploid lethal hybrids. Further studies up to the time of the death of the hybrids are in progress.

It is of interest to note that the chromosomes of the blastulas form karyomeres which fuse to form double nuclei or hemikaryons in many cells. These are present in both the diploid *pipiens* and the diploid hybrids. Double nuclei appear in a few cells of the haploid *pipiens* and the haploid hybrids and may be a result of the incomplete fusion of the karyomeres.

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Probability of Seeing Functions for Near-Instantaneous Thresholds

C. G. Mueller and L. R. Wilcox, ***Columbia University***

Probability of seeing as a function of stimulus intensity was measured for a circular stimulus area, 30 min in diameter, presented to the fovea. Measurements were made immediately following adaptation to intensities ranging from near cone threshold to 10,000 millilamberts. The procedure at each adapting intensity was as follows: after the eye was adapted to one of the adapting intensities, the cycling of adapting and test stimuli was begun. The period of this cycle was 10 sec and began with the interruption of the adapting stimulus. After a dark period of 0.2 sec the test intensity was presented. After another dark period of 0.4 sec the adapting stimulus came on for the remainder of the 10-sec period. This cycle was repeated until a complete frequency of seeing function was obtained.

Three subjects were run at 14 adapting intensities. Two exposure durations, 6 and 50 msec, were studied.

The average thresholds as a function of adapting intensity yield a function of the same general form as shown in earlier results in the literature. The maximum slope of the probability of seeing functions increases as the threshold increases and as the adapting intensity increases from near threshold to approximately 100 times this value. Changes in adapting intensity beyond this point have relatively less effect on the slope of the psychophysical function, and there is some indication that the slope decreases at high adapting intensities. The changes in slope that accompany the change in threshold at low adapting intensities are considered in relation to a "quantal" type of theory of the threshold effect.

Hyperfine Structure of the $n = 3\ ^2P_{1/2}$ and $^2P_{3/2}$ States of Sodium-23 by an Atomic-Beam Method

M. L. Perl, I. I. Rabi, B. Senitzky, ***Columbia University***

The hyperfine structure of the $n = 3\ ^2P_{1/2}$ and $^2P_{3/2}$ excited atomic states of Na^{23} have been investigated using a modification of the atomic-beam method proposed by Rabi [*Phys. Rev.* 87, 379 (1952)]. The apparatus has conventional A and B inhomogeneous deflecting magnets, which are arranged so that a change of electronic moment is required for an atom to be refocused, that is, to hit the detector wire. A beam of sodium atoms in the ground state ($n = 3\ ^2S_{1/2}$) transverses the A magnet and enters the homogeneous C field region. Resonance radiation from a sodium discharge lamp illuminates the C region and excites part of the beam to the $n = 3\ ^2P_{1/2}$, $n = 3\ ^2P_{3/2}$, and possibly higher states. The excited atoms decay to the ground state before leaving the C field region, but in so doing, about one-third of them end up in hyperfine ground states having opposite electronic moments from their initial hyperfine ground states. These atoms are refocused

and produce a signal depending on the light intensity.

If an oscillating magnetic field of a frequency corresponding to an excited-state hyperfine transition is applied in the C field region simultaneously with the optical radiation, some of the excited atoms change their excited hyperfine state before decaying. In our experiment this results in an increase in the number of refocused atoms. If the frequency of the oscillating field is varied across the transition frequencies of the excited-state hyperfine structure, the plot of increase in refocused atoms with frequency gives the spectra of the excited state.

Using this method with a near zero static magnetic field in the C region we have found the F = 0 to F = 1 line in the $^2P_{1/2}$ and the F = 2 to F = 3 line and the F = 1 to F = 2 line in the $^2P_{3/2}$ state. We have not been able to find the apparently weak F = 0 to F = 1 line in the $^2P_{3/2}$ state. By increasing the static magnetic field in the C region we have also studied the Zeeman and Paschen-Back effect in both excited states. At present the investigation of the sodium excited states is being continued and the method is being extended to other elements.

17-Keto-17a-Methyl-D-Homosteroids from 17α-Hydroxy-20-Amino-C_{21} Steroids: Stereochemistry of D-Homoannulation

Fausto Ramirez and Stanley Stafiej, *Columbia University*

The action of nitrous acid on a 17α-hydroxy-20α-amino steroid III (R′ = H) (3β,17α-dihydroxy-29α-aminoallopregnane) has been studied with the view of (i) correlating the configurations at carbons 17 and 20 with the course of deamination and (ii) providing a new route to C_{21}-D-homosteroids. It was found that the amino alcohol III (R′ = H) rearranged exclusively with migration of the 13-17 bond to a 17-keto-17a-methyl-D-homosteroid V (3β-hydroxy-17a-methyl-D-homoandrostan-17-one). This result is interpreted in terms of steric strain in the transition state of the deamination and is compared with the previously reported D-homoannulation of 17α-hydroxy-17-aminomethyl steroids, in which no steric bias is associated with carbon-20.

The amino alcohol III (R′ = H) was obtained, together with a small amount of the 20β-epimer IV (R′ = H), from the catalytic hydrogenation of a 17α-hydroxy-20-oxime (II) (3β,17α-dihydroxy-20-oximidoallopregnane). The configurations of the amino alcohols are based on the molecular rotation differences between the 20-epimeric acetamido derivatives (III, R′ = Ac and IV, R′ = Ac) by comparison with previously reported molecular rotation differences of 20-epimeric 20-acetate derivatives of 17α,20-dihydroxy steroids of analogous constitution (that is, products of the reduction of I at carbon-20). The oxime II (or its 3-monoacetate) was prepared in quantitative yield from 3β,17α-dihydroxyallopregnane-20-one (I, R = H) (or its 3-monoacetate, I, R = Ac).

Generation of Bioelectric Potentials

David Nachmansohn,
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Electric currents propagate impulses along nerve fibers and other conducting tissue. The source of the electromotive force of these currents is ionic concentration gradients: Na ions are much higher on the outside of the cell than in the interior. The opposite is true for K ions. During activity there is a sudden influx of Na^+ followed by an equivalent outflow of K^+. Knowledge of the mechanism by which nerve fibers suddenly become more pervious to Na^+ for a fraction of a millisecond, as physical recordings indicate, is fundamental to understanding nerve function.

Studies of chemical reactions and of the sequence of energy transformations associated with the generation of bioelectric potentials have shown that the acetylcholine system is essential for the change in ion permeability. Electric organs, the most powerful bioelectric generators created by nature, offered an important tool. The following picture of the elementary process has emerged.

Acetylcholine is present in a bound form. Released by a stimulus it acts upon a "receptor" protein which, in this reaction, apparently changes its configuration. This process seems to be responsible for the permeability change. The free ester is inactivated by the enzyme acetylcholinesterase, the receptor returns to its original condition, and the barrier for ions is reestablished. In the recovery process acetylcholine is resynthesized by the enzyme choline acetylase. The energy provided by ATP hydrolysis and the glycolytic and citric acid cycles are all essential in recovery mainly for restoring the disturbed ionic equilibrium. The molecular forces in the active surface of the various proteins of the system reacting with acetylcholine differ markedly in their reaction with quaternary nitrogen compounds compared to that with the tertiary analogs. Presence of a fourth alkyl group on the nitrogen does not markedly affect the binding forces but greatly enhances functional activity. This applies to the two enzymes as well as to the receptor protein: tertiary nitrogen compounds structurally analog to acetylcholine are able to block propagation, the quaternary analogs block and in addition simultaneously depolarize the cell, suggesting that they have a greater ability to produce the change of the receptor protein responsible for the increased permeability.

Ordering Processes in Cu_3Au

S. L. Quimby, *Columbia University*

Details of the several processes by which equilibrium order is achieved in specimens of Cu_3Au quenched from a temperature above the critical temperature to one below it, are revealed by F. P. Burns' measurements of the isothermal time variation of electric resistivity following the quench. Above about 360°C the initial process is the formation, by statistical fluctuation, of stable antiphase nuclei of low order in the disordered matrix. The nuclei grow until their boundaries are contiguous, and simultaneously the order within them increases to the equilibrium value for the temperature. The rate of fall of resistivity produced by this process *increases* as the quench temperature is lowered. The end-result is a mosaic of antiphase domains, and the succeeding process is the coalescence of these domains to form the highly stable structure compared by Bragg to that of a stable foam. Subsequent coalescence is extremely slow. Quantitative estimates of the nuclear size, based upon their computed surface and volume free energies, are consistent with x-ray measurements of domain size.

Below 360°C the density of nuclei is sufficiently great that the nuclear boundaries are nearly contiguous on formation. The dominant process following the formation of nuclei is domain coalescence. The rate of fall of resistivity *decreases* as the temperature is lowered.

The true kinetics of the ordering and disordering proc-

esses, freed from phenomena associated with antiphase domains, are revealed by measurements made on a specimen after annealing for upward of 50 hr. The observed time variation of resistivity following sudden changes of temperature below the critical temperature are in excellent agreement with the simple kinetic theory of bimolecular processes recently proposed by Jerome Rothstein.

Interaction of Instrumental and Autonomic Responses in Avoidance Conditioning

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Columbia University

Two experiments are reported testing the hypothesis that acquisition of any instrumental avoidance response (R_{AV}) weakens autonomic CR's (conditioned responses) acquired during avoidance training wherein both Pavlovian and Thorndikian paradigms figure. This weakening is predicted from the absence of US (unconditioned stimuli) on successful R_{AV} trials, and also from the discriminative control assumed by stimuli produced by, or accompanying, R_{AV}.

In these experiments, the CR under observation was the heart-rate depression developed in human subjects upon repeated exposure to tone (CS) followed by electric shock (US). CR was measured by comparing pretone heart rate with that in the CS-US interval. A trace conditioning procedure was used: 1-sec tone, 6-sec CS-US interval, 6-sec shock.

In experiment 1, 20 subjects were given eight trials each of CR acquisition, followed by R_{AV} (a key-tap during the fourth second of the tone-shock interval) acquisition by each subject to a criterion of five successive avoidances. Both the number of subjects (15 out of 20) with diminished CR's and the diminution in group mean CR indicate that during the avoidance criterion trials CR was significantly lower ($P < .05$) than during acquisition.

Experiment 2, with 10 new subjects, replicated experiment 1 with the exception that each successful R_{AV} during avoidance training was immediately followed by an exteroceptive signal (1.5 sec light). Again, both by the number of subjects (9 out of 10) with diminished CR's and by the diminution in group mean, CR during the avoidance criterion trials was significantly lower ($P < .02$) than CR during acquisition, this reduction being even greater than in experiment 1 because of the additional discriminative cue.

Both experiments thus confirm the original hypothesis.

Anatomy of the Magellanic Clouds

Harlow Shapley and Virginia McK. Nail,
Harvard University

The nearest of galaxies outside our own, the Magellanic Clouds at a distance of 170,000 light-years, are neither spiral nor spheroidal in form but of the less usual irregular type. The Large Cloud of Magellan, dominated by a long stellar axis or bar rather than a nucleus, can properly be classed as a quasi-barred spiral. Our current investigations concern the dimensions and topography, the dark and bright nebulosities, the supergiant stars, and the star clusters in both Clouds.

Of most interest is our study of the 300 cepheid variable stars scattered along the bar of the Large Cloud. We seek to find what light these cepheids can throw on the tilt of the bar and on the tilt of the whole Cloud with respect to the tangential plane. It is not yet proved, however, that the Large Cloud is a flattened system. Eventually, as the precision of the photometry increases and our information about the location and motions of the hydrogen gas in and surrounding the Large Cloud is extended by the radio-telescopes at Sydney, Australia, we should unravel both the form and the inner turbulences of this important galaxy.

Unexpectedly we find that the cepheid variables at the west end of the Large Cloud's bar, simulating the cepheids in the core of the Small Cloud, are preferentially larger, brighter, and of longer period than in the center or at the east end.

Our recent work has shown that many of the supergiant stars are reddish, variable, and in radiation exceed the sun 50,000 times. A few of the bluish supergiant stars in the so-called "constellations" within the Large Cloud radiate at a rate in excess of 200,000 suns, and thus we have the remarkable situation in which a single star emits more radiant energy than is emited by all the tens of thousands of giant and average stars in the average globular star cluster.

Olation in Certain Basic Metallic Salt Solutions

Arthur W. Thomas, ***Columbia University***

The polymerization in aqueous solution of basic chromic, ferric, and aluminum ions to form polyolated and/or polyoxolated complexes is briefly discussed, especially with regard to determinations of rates of such reactions.

In vivo Conversion of C_{21}-17α-Hydroxylated Steroid to C_{21}-17-Desoxymetabolites

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Seymour Lieberman, Joseph W. Jailer,
Columbia University College of Physicians and Surgeons

As the title indicates, proof has been obtained for the existence of a novel metabolic pathway for the catabolism of adrenal steroids. 11β,17α-Dihydroxy-4-pregnene-3,20-dione (21-desoxy hydrocortisone) was administered to two Addisonian patients whose ketosteroid excretion values at the time of the experiment were 4.0 and 4.4 mg/day, respectively. The urinary metabolites of the administered compound were isolated by gradient elution chromatography. Along with several unidentified compounds, the following steroids (not present in control urines) were identified by infrared spectroscopy: 11-keto-androsterone, 11-keto-etiocholanolone, 11β-hydroxy-androsterone, 11β-hydroxy-etiocholanolone, 3α,17α-dihydroxy-pregnane-3,11,20-trione and 11-keto-pregnanolone (3α-hydroxy-pregnane-11,20-dione). The recovery of the last-named compound (identity confirmed by melting point and mixed melting point) establishes the existence of an *in vivo* metabolic pathway by which a tertiary 17α-hydroxyl group of a C_{21}-steroid is replaced by hydrogen.

The presence of this pathway has been confirmed by another experiment in which 17α-hydroxy-progesterone was given to another Addisonian patient who was excreting no discernible ketosteroids at the time of the experiment. Pregnanolone (identity by melting point, mixed melting point, and infrared spectra) was isolated from the urine, and this again demonstrates the metabolic elimination of the 17α-hydroxy group. The importance of this finding for the establishment of hormonal precursor-metabolite relationships is discussed.

Cross Section of Hydrogen Compounds for Very Slow Neutrons

T. I. Taylor, R. R. Smith, W. W. Havens, Jr., *Columbia University*

For low-energy neutrons the theoretical value of the cross section of hydrogen bound tightly to an infinitely heavy atom should be about 81 barns [Fermi, *Ricerca sci.* 7, 13 (1936)]. The effective *n-p* cross section is considerably increased in molecules where the neutron can either gain or lose energy by interactions involving molecular motions [Arley, *Kgl. Danske Videnskab. Selskab Mat. fys. Medd.* 16, 1 (1938)]. To study this effect, the cross sections of gaseous methane (CH_4) at two different temperatures, liquid water (H_2O), polyethylene $(CH_2)_x$, and barium hydride (BaH_2) have been measured for neutrons with wavelengths from 3.5 to 10 A. These measurements were made at Brookhaven National Laboratory with the slow neutron chopper [Seidl *et al.*, *Phys. Rev.* 82, 345 (1951)] and a crystal monochrometer using mica in conjunction with filters to remove diffracted neutrons of higher orders.

The cross section of methane is nearly linear with wavelength from 4 to 10 A where it changes from 312 to 685 barns per molecule. Subtracting the absorption cross section of hydrogen and the scattering cross section of carbon and then dividing by 4 to obtain an effective cross section per proton in the molecule gives 76 barns at 4 A and 168 barns at 10 A or a slope of 15.3 barns/A. At −78°C the effective cross section per proton in the molecule was reduced to 77.6 barns at 5 A and 99.9 barns at 7 A, giving a slope of 11.2 barns/A. Changes in translation and rotation of the methane molecule should account for the major part of this decrease in cross section. A theoretical treatment is in progress, but it has not yet been completed.

Curves for the effective cross section per proton for water and for polyethylene as a function of neutron wavelength are nearly the same in the wavelength range from 4 to 10 A, varying from about 81 to 121 barns with a small curvature. The curve for barium hydride follows that to be expected from a proton bound tightly to a heavy atom up to about 5 A; it then increases slowly from 70.5 barns at 5 A to 77 barns at 10 A.

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Nucleocytoplasmic Interchange in Oocytes

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Ultrathin sections (0.02 to 0.05 μ) of frog ovaries that were fixed in osmium tetroxide have been studied with the electron microscope. In early oocytes, before yolk deposition, the nuclear boundary, or membrane, appears in vertical section as a series of evenly spaced dense bodies interspersed with a continuum of much lower density. In tangential sections of the membrane these bodies appear circular, with a peripheral ring of denser particles; commonly there is also a central body, similar to those in the ring. From the outer surface of each of the large dense bodies there projects into the cytoplasm an unbranched, threadlike, structure, which appears to be nodulated, or to show a suggestion of helical form. From the inner surface of each large dense area a delicate, highly contorted thread extends into the nucleus, sometimes terminating in the nucleolus. In sum, these appearances at the nucleocytoplasmic boundary seem consistent with the view that the large dense areas are regions where a threadlike substance is continuous from nucleus to cytoplasm.

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Historical Geology, Dynamic Geology, and Recoverability

Arthur N. Strahler, *Columbia University*

Geology is concerned with two fields of inquiry: (i) Physical, or dynamic, geology is a study of the geologic processes and the characteristic forms they produce. (ii) Historical geology reconstructs a series of events and assemblage of forms produced at a particular place and time in the past. A more fundamental distinction between the two fields may be made by introducing the concept of probability of repeated occurrences of given states of matter. In this light, dynamic geology deals with forms and events that may be expected to recur frequently in geologic time and, therefore, provide the basis for formulation of general laws and for offering predictions. Historical geology, on the other hand, describes assemblages of geologic forms and sequences of events so complex that probability of repetition at any place or time, past or future, is extremely small, and the particular state is therefore virtually irrecoverable.

Under these definitions we can reject as trivial the distinction accepted by Kirk Bryan and Leland Horberg in which the sole criterion for differentiating between dynamic and historical geology is whether the processes involved are acting now or have ceased to act.

Function of the Right Ventricle—an Obscure Hydraulic Problem

Carl J. Wiggers, *Cleveland Clinic*

Since the time of Harvey, the heart has been regarded as a four-chamber pump. For some time it has been recognized that the auricles are of only subsidiary importance; their pumping action can be spared. During the past decade it has been proved experimentally that up to 80 percent of the right ventricular walls can also be destroyed without affecting the transfer of blood through the lungs to the left heart—even under stress of greater pulmonary resistance or exercise. Clinically, such demonstrations should question diagnoses of right-heart failure.

Physiologically, the source of energy through which the right ventricle still functions with almost normal efficiency has no satisfactory explanation. The suggestion that the propulse action of the damaged right ventricle is caused by a pull of left ventricular muscle bands upon continuous, but damaged, bands of the right ventricle (Bakos) does not square with the demonstration that the right ventricular wall is not pulled in but expands during ejection of blood (Kagan). The concept that the right ventricular wall has so great a factor of safety that 20 percent of scattered contractile elements can take over the work of the right ventricle, even under stress (Donald and Essex), is untenable, because (i) the ventricular wall, as a whole, does not contract but bulges, and (ii) in the same animal, the ability of the damaged ventricle

to overcome a measured pulmonary resistance is surprisingly little less than that of the undamaged ventricle (Kagan).

The concept that shortening of the apex-base axis of the thick interventricular septum may be largely responsible for creation of pressure in the right ventricle (Kagan) is not supported by the following evidence. (i) The relative onset and offset of right and left ventricular systoles can vary from time to time. (ii) Artificial excitation causes precedence of contraction and a more gradual rise to a lower maximum systolic pressure only on the side stimulated. (iii) The contractile force may increase in one ventricle and diminish in the other. (iv) Normally, shortening of surface fibers is proportional to the pressure developed in the right ventricle. (v) In defects of the ventricular septum, the initial push of blood into the pulmonary artery is given by the right ventricle and is completed by a delayed auxiliary force from the left ventricle.

Gravity Anomalies at Continental Margins

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Gravity anomalies along seven profiles across the eastern continental margin of the United States from Cape Hatteras to Nova Scotia are presented. Geologic sections along the profiles are deduced from the gravity anomalies with the aid of available seismic evidence in the area. The transition from ocean-type to continental-type structure at continental margins is discussed in the light of this gravity evidence.

Intermediate Coupling Theory for Nuclear Reactions

E. P. Wigner, ***Princeton University***

Almost all nuclear cross sections exhibit, at not too high energies, a kind of line structure with rather sharp maxima and relatively low values between the maxima. It was believed, until rather recently, that the frequency and width of the states, which are responsible for the line structure of nuclear cross sections, are rather smooth functions of the energy of the incident particle. However, more recent experiments of Barschall have definitely demonstrated that the product of the density and width of these states shows large-scale fluctuations. Furthermore, a satisfactory account of the energy dependence of this product was given by Feshbach, Porter, and Weisskopf and by Adair by means of their clouded crystal ball model.

It was pointed out in earlier work with Eisenbud and with Teichmann that, in the independent particle model, only the states based on the unexcited target nucleus have a finite width and, hence, that only these contribute to the cross section. In the many-particle model, these states share their widths with other states. If one assumes that, as a result of this sharing, all states have about the same width, the cross section will show no gross structure. Such a gross structure is obtained, however, in the intermediate case of some, but not complete, sharing of the width among the states. In this case, the levels close to the original single-particle state obtain the lion share of the width that the single-particle state possessed originally. The distance, in energy scale, of the states that still acquire an appreciable width is directly given by the deviation from the single-particle picture. According to the model arrived at, the gross structure in the cross section is the result of fluctuations in the width, rather than the density, of the states responsible for the line structure. It appears possible also to find an explanation for the angular dependence of the velocities of the reaction products.

Reactivation of Enzymes Inhibited by Certain Highly Toxic Agents

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Certain phosphate esters such as tetraalkylpyrophosphates, dialkyl fluorophosphates, and dialkyl p-nitrophenylphosphates are potent irreversible inhibitors of acetyl cholinesterase, an enzyme, vital for nerve function. Some important insecticides and the most toxic chemical warfare gases are of this type and owe their poisonous character to the inhibition of acetylcholinesterase. Since the action of these compounds is not restored by dilution or dialysis, it was held that the enzyme activity was irrevocably destroyed by these compounds. But the development of enzyme theory clarified the mechanism of inhibition and suggested means of reactivation. During the hydrolysis of carboxylic esters an acylated enzyme is formed that reacts rapidly with water to regenerate the active enzyme. In the case of these irreversible inhibitors the enzyme is phosphorylated, but in contrast to the acylated enzyme the phosphoryl enzyme reacts only very slowly with water. These compounds are, therefore, not substrates.

Theory suggests that reagents capable of making a nucleophilic attack on the phosphorus atom should regenerate the enzyme in an essentially SN_2 reaction. And in fact, compounds containing amino, hydroxyl amino, pyridyl, guanidino, amidino, hydroxyl, or mercaptyl groups are effective reactivators.

In addition to the esteratic binding site, this enzyme contains an anionic site which contributes to the catalytic action of the enzyme by binding and orienting cationic ammonium structures such as those contained in the physiological substrate acetylcholine. This site is not directly affected by these inhibitors and still functions in the inhibited enzyme. Accordingly the best reactivators are the compounds, such as nicotinehydroxamic acid methiodide, that contain a nucleophilic group and a cationic ammonium structure.

A Homomorphism Sequence Based on Loops

P. A. Smith, ***Columbia University***

Let K be a connected geometric complex. We associate to K a homomorphism sequence of order 2:

$$\rightarrow F_n \rightarrow F_{n-1} \rightarrow \qquad \rightarrow F_1 \rightarrow 1,$$

in which F_1 is the group of combinatorial loops with fixed base point and F_m is abelian for $m > 2$. The construction is purely algebraic and is suggested by homotopy, rather than homology, concepts. The groups

$$p_n = \text{kernel } (F_n \rightarrow F_{n-1})/\text{image } (F_{n+1} \rightarrow F_n)$$

are invariant under standard operations on complexes but, except for $p_1 = \pi_1$ and $p_2 = \pi_2$, have yet to be identified under general conditions. On the other hand, if $p_1 \ldots p_{n-1}$ are trivial then p_n is the integral n-dimensional homology group based on finite classes. For a 2-sphere p_3 is infinite.

Role of Thioesters of Amino Acids in the Synthesis of the Amide Bond

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The role of acyl mercaptans in the synthesis of fatty acids suggests the possibility that amino acids in thioester linkage with SH groups either of enzymes or of coenzymes as yet not recognized act as intermediates in peptide synthesis. Such intermediates may be most easy to demonstrate in the biosynthetic reactions involving the γ-carboxyl of glutamic acid as in glutamine or glutathione (GSH) synthesis. A study of the behavior of model substrates under enzymatic and nonenzymatic conditions offers an experimental approach to this problem.

Both α- and γ-thioesters of glutamic acid with glutathione as the mercaptan were synthesized in an unequivocal manner. The γ-isomer decomposed rapidly into GSH and pyrrolidone carboxylic acid. S-α-glutamyl-GSH and both isomeric thioesters of carbobenzyloxy glutamic acid and GSH were split by a thioesterase preparation from brain and liver. Different ammonium sulfate fractions of liver showed constant ratios of activity toward the glutamic-acid thioesters and toward S-acetyl-GSH. However, this was not observed for other aminoacyl and acyl mercaptans. In aqueous solution at *p*H 7.6 S-α-glutamyl-GSH was converted to an extent of about 50 percent to N-α-glutamyl-GSH by transfer of the glutamyl radical from the thioester bond to the α-amino group of GSH with formation of an α-peptide linkage.

Studies on the Chemistry of Mutation

Stephen Zamenhof, *Columbia University*

The purpose of this work (done in collaboration with Hattie E. Alexander and Grace Leidy) is to study the correlation between the change in chemical structure and the change in function of one alleged hereditary determinant, DNA. The results obtained in this laboratory suggest that the removal of less than ½ percent of total amino groups (and/or hypothetical H-bonds to these groups) results in total inactivation of DNA. On the other hand, we find that the replacement of more than 10 percent of methyl groups in thymine (of DNA) by bromine or iodine does not result in either inactivation or demonstrable mutation. The cells with such unnatural DNA may grow at a normal rate and cannot be distinguished from the normal ones. This seems to indicate that while certain profound changes in the structure of the DNA molecule may be without consequences, the maintenance of the original pattern of electric charges is essential.

In nature, the heritable change of this pattern may occur through change of sequence and/or proportion of nucleotides in an integral DNA molecule. This process can be visualized at present only as a (rare) fault occurring during DNA reproduction; this process, then, may be the chemical basis of mutation. However, the probability and the location of the fault along the DNA molecule may be determined by a preceding process postulated as gene unstabilization. We find that this unstabilization occurs also in DNA *in vitro* under the action of various mutagenic agents. On reproduction, the unstabilized DNA becomes again stable.

RaE β-Spectrum and the Pseudoscalar Interaction

C. S. Wu, *Columbia University*

The radiations from RaD and RaE have been systematically studied in this laboratory. The RaE β-spectrum has been reinvestigated in the solenoidal magnetic spectrometer. By taking into consideration the effect of a finite de Broglie wavelength, the β-spectrum can be fitted with a linear combination of (S,T) and a spin and parity change of $1^- \rightarrow 0^+$. This is in good accord with the determination of the spin of RaE. Existence of the pseudoscalar interaction will be discussed.

Vacuum Polarization in a Strong Coulomb Field

Eyvind H. Wichmann and Norman M. Kroll,
Columbia University

One interesting and important consequence of the Dirac hole theory is the appearance of a charge density in the vacuum simply as a consequence of the application of an electrostatic field. This induced charge density, generally referred to as the vacuum polarization charge density, has been previously calculated for the case of a weak field of arbitrary form and for a uniform field of arbitrary strength. Furthermore, its existence has been experimentally verified in connection with the fine structure of hydrogenic atoms.

The case of a strong coulomb field is of interest in connection with experiments that explore the nuclear electrostatic field in detail, since the polarization charge will, of course, modify this field. There is also some general theoretical interest in the avoidance of weak-field approximations and in the convergence of the power series expansion in the parameter which characterizes the field strength, in this case, the nuclear charge.

To deal with this problem we make use of the fact that the polarization charge can be expressed in terms of the solutions to the Dirac equation, which, for the case of the coulomb field, are known. These solutions can be used to express the Laplace transform of the charge in a relatively tractable form. The power series expansion of the Laplace transform can be shown to converge for all values of the nuclear charge for which the Dirac equation has proper solutions. The behavior of the polarization potential at small distances has been discussed completely. The corrections to the weak-field approximation are small for all allowable values of the nuclear charge.

Rice and Health in Asia

Robert R. Williams, *Research Corporation, New York*

In the most populous parts of Asia rice is the staple food. From it is derived 80 to 90 percent of the daily caloric intake of some 800 million people. In large areas of Asia, though not in all, overcrowding of the land forbids diversification of diets with large components of foods of animal origin.

Correction of the nutritional shortcomings of rice by undermilling it, parboiling it, or reenforcing it with products of chemical manufacture presents the only possible early, though partial, solution of Asia's food problems. The possibilities and progress to date are reviewed with special reference to the Philippine as a trial area.

News and Notes

Current Activities in Psychology

Approximately 6000 psychologists met in New York on 3–8 Sept. for the 62nd annual meeting of the American Psychological Association. The presidential address, given by O. Hobart Mowrer of the University of Illinois, was on the topic "The psychologist looks at language." Based on a thorough survey of the scientific study of language, the address emphasized that findings in many fields of psychology, such as learning, perception, psychotherapy, and so forth, are relevant to research on language and that the sentence, as a unit of meaning, needs to be viewed from a psychological standpoint.

The 17 divisions of the association sponsored 364 programs of individual research papers, symposiums, discussion groups, and addresses. Following are a few examples of the kinds of activities and reports that took place during the meetings.

D. O. Hebb (McGill University), in a symposium on *Unlearned Behavior,* challenged the "exaggerated role of heredity" in both mental disease and in intelligence assigned by some scientific workers. He pointed out that no behavior in mammals, including man, aside from reflexes, is either altogether innate or learned. No behavior is independently governed by heredity or environment. The trouble has been, according to Hebb, that some research on mental disease, the emotions, and the intellect has obscured the environmental factors by controlling them in experiments.

James Olds (McGill University) reported on a research study, using rats as subjects, in which it was shown that direct electric stimulation of various parts of the brain has a reinforcing, or rewarding, effect on the animal's behavior. Moreover, it was reported, this reinforcing effect is not the same in all parts of the brain, with the most positive response being obtained from the septal area, a relatively neutral response from the hippocampus, and negative reinforcement from the primary sensory pathways.

Marilyn K. Rigby and Walter L. Wilkins (St. Louis University) reported on a comparison between militarily oriented and clinically oriented approaches to the definition of selection problems. When psychologists and psychiatrists attempt to determine and specify the personality attributes essential for success in a military assessment situation, problems of misunderstanding between them and military officers frequently arise. In this study it was discovered that if these personality characteristics are presented in behavioral terms, rather than by their trait or attribute names, a high degree of agreement on what is relevant can be achieved. John R. Barry, Saul B. Sells, and Bart Cobb (USAF School of Aviation Medicine, Randolph Field) reported that the cadets who are best adjusted to the aviation training program have a history of participation in active, athletic, thrill-seeking activities to a greater extent than those who are inadequately adjusted.

Norman Frederiksen and D. R. Saunders (Educational Testing Service) reported on a "working test" for executives, known as the "in-basket" test. The aspiring executives, Air Force officers in the original research, were confronted with an in-basket full of letters, memoranda, and so forth, calling for action. They were cast in the role of a wing commander, or chief of a staff division of the imaginary Air Force wing, and they were given 2 hr in which to clear out their in-baskets.

From information obtained in interviews with 1000 persons who had recently been involved in 70 different disasters, such as tornadoes, earthquakes, and train wrecks, Eli S. Marks and Charles E. Fritz (National Opinion Research Center) reported that "behavior in the disasters studied has been much more rational and controlled than might be assumed from the popular literature on disaster." The report concluded that

> The amount of prior warning of a disaster impact may have a very substantial influence upon the severity of the losses sustained and the type of reaction exhibited. While respondents with considerable forewarning of disaster impact are likely to react more adaptively (and to sustain lesser loss) than those with no forewarning, there is evidence which suggests that *very brief* forewarning periods may be harmful rather than helpful.

At a symposium, *Some Contributions of Psychology to the Understanding and Appreciation of Other Academic Fields,* the place of psychology in interdisciplinary courses was described by Irwin A. Berg (Northwestern University) and Clarence Leuba (Antioch College). At Northwestern a 1-yr course in social science is presented jointly by the departments of anthropology, psychology and sociology, while at Antioch a 2-yr course on man covers the fields of anthropology, biology, psychology, and sociology.

The role of the psychologist in the medical school was discussed by Milton Horowitz (Western Reserve University) at a symposium, *Psychology in the Redevelopment of Curricula in Medical Schools.* In addition to his clinical responsibilities, the psychologist participates in the planning and giving of lectures and demonstrations on topics with which he has a special familiarity, leads staff seminars dealing with recent developments in fields related to various medical disciplines, and cooperates in research projects with both staff members and students.

The Thayer Work Conference on Functions, Qualifications, and Training of School Psychologists was held for 10 days preceding the convention. Requested by the APA Division of School Psychologists, this conference was sponsored by the APA Education and Training Board and financed by a grant from the U.S. Public Health Service. The reports of the conference strongly supported the movements already begun in various other areas of psychology for establishing uniform standards of training requirements for school psychologists.

It was announced during the convention that the first national registry of persons and agencies qualified to give psychological services is being prepared by a separately incorporated organization named the American Board of Psychological Services. For the first year members of the board will be Nathan Kohn, Jr., Karl F. Heiser, Wendell S. Dysinger, Roy Brener, and Arthur L. Irion.

E. Lowell Kelly (University of Michigan) will serve as president of the American Psychological Association during 1954–55.

STAFF, *American Psychological Association Washington, D.C.*

Synchronization of Cell Division in Microorganisms

An important problem in microbiology is the study of the variation in properties that must occur during the stages in the division cycle of cells. Such studies in the populations of growing cells are difficult because of the random occurrence of cell division which results in a smooth exponential increase in the total amounts of cell components and metabolic activities. Recognition of this problem has resulted in a number of recent papers devoted to techniques for the synchronization of cell division and to the properties of synchronized cultures.

Starting with single *Tetrahymena* cells. E. Zeuthen [*J. Embryol. Exptl. Morphol.* **1**, 239 (1953)] was able to study synchronized growth through four division cycles. He made the rather surprising observation that the respiratory activity per cell increased linearly rather than exponentially during the interval between cell divisions in which the cells were increasing in size. This suggested that growth, when divorced from cell division, is not autocatalytic. O. Scherbaum and E. Zeuthen [*Exptl. Cell Research* **6**, 221 (1954)] then developed a method for the synchronization of cell division in mass cultures of *Tetrahymena*. A growing culture was raised from the optimum growth temperature of 29°C to the sublethal temperature of 34°C for ½ hr. This interrupted cell growth and the initiation of cell division, but it did not prevent the completion of divisions already in progress. On the return of the culture to 29°C, synthesis of protoplasm resumed, but there was no cell division. During 8 hr of these cyclic temperature changes, the cells increased three- to fourfold in size without cell division. If the culture was then held at 24°C, there was a lag period of about 90 min, after which about 85 percent of the cells divided nearly simultaneously. Two additional division cycles followed at less than 2-hr intervals, the proportion of synchronized cell divisions gradually decreasing. Further information [in press] about this system was reported by Zeuthen and Scherbaum at the Colston symposium on cell physiology.

A remarkable physiological change correlated with synchronized cell divisions was described by R. D. Hotchkiss [*Proc. Natl. Acad. Sci. (U.S.)* **40**, 49 1954)]. Using pneumococcus, a culture growing at 37°C was cooled quickly to 25°C. After 15 min at 25°C, a return of the culture to 37°C resulted in a prompt division of most of the cells in the culture, followed 30 min later by a second wave of divisions. The susceptibility of the culture to genetic transformation with pneumococcal DNA increased markedly during the period at 25°C and then decreased abruptly to a low level during the subsequent period of rapid cell division at 37°C. Following this minimum, there was a second peak of susceptibility to transformation, often higher than the first maximum. Appropriately spaced alternations of temperature maintained the culture in phase during several cycles of changing susceptibility to transformation.

Another example of a synchronized cyclical change in physiological properties was also reported at the Colston symposium by O. Maaloe and K. G. Lark [in press]. A culture of *Salmonella typhimurium* could be forced into synchronous cell division by alternating periods of 28 min at 25°C and 8 min at 37°C. The physiological property under study was the conversion of the bacteria to the lysogenic state by infection with a temperate bacteriophage. The efficiency of lysogenization per bacterial cell doubled coincidentally with an increase in the average number of nuclear bodies from two to four per cell, and then decreased to the initial value during cell division, which restored the average nuclear frequency to two per cell. Further details of the synchronization procedure have been reported by Lark and Maaloe [*Biochim. et Biophys. Acta* (in press)].

It seems evident that the synchronization of cell division in cultures of microorganisms may aid the solution of many problems. It is possible, for instance, that an enlightened application of such techniques might help to resolve those controversies in the field of bacterial cytology that have a factual basis.—M. H. A.

Science News

Secretary of Commerce Sinclair Weeks has announced the appointment of an **Advisory Committee on Application of Machines to Patent Office Operations.** Its chairman is Vannevar Bush, president of Carnegie Institution of Washington. Secretary Weeks said:

> The establishment of this Committee of outstanding experts is aimed at finding new ways to speed up the processing of patent applications, thereby stimulating economic growth and employment that result from new inventions. . . . Each individual patent application requires reference to innumerable patents to determine whether the idea is brand new. As the field of invention is constantly being enlarged, the field of individual processing likewise must be expanded.
>
> If high speed electronic devices can be used to replace time-consuming manual sorting and searching of reference material, the result could be a tremendous boon to inventive progress.

The publication last August of the so-called "Riehlman Report," the report of the Committee on Government Operations that is formally titled *Organization and Administration of the Military Research and Development Programs,* stimulated a good deal of public comment. Recently a complete transcript of the extensive hearings that led to that report has been made available. This detailed record, which includes the testimony of many well-known scientists, has renewed interest in the Government's administration of scientific research and has resulted in a number of published statements. Among them is the following editorial, which appeared in the 1 Nov. issue of *Time*.

> The worried debate about the relationship of science and government got a going-over last week from widely divergent angles. In a new Government document, *Organization and Administration of the Military Research and Development Programs*, the scientists told some of their own troubles. In an impressive editorial, the Protestant *Christian Century* pointed out the cause of their distress.
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> The Government document, a book of 710 pages, is the record of hearings last June before a House of Representatives subcommittee. What the committeemen heard was not reassuring. Individualistic scientists, said witness after witness, cannot be regimented and still work at their best. When they are put under military command, as in the many laboratories of the armed services, they feel that they are misunderstood and their capabilities wasted. Said William Webster, executive vice president of the New England Electric System, twelve years a naval officer: "A military organization is a very trying climate for the best work of scientists."
>
> The most violent opinion was expressed by John William Marchetti, who resigned last May as electronics director of the Cambridge Air Force Research Center after a row with a new commanding officer. Said Marchetti: "We got decisions that were stupid, just plain stupid, and some that were intolerable." He did not blame the military men for all the friction: "It is one clique pitted against another. . . . 'It is said of a well-known Air Force research and development center that at the officers' club the relative ranks are officers, enlisted men, dogs and civilians.' "
>
> Calmer witnesses testified that much of the trouble comes from the military habit of rapidly "rotating" the commanding officers of a laboratory. Sometimes these birds of passage stay a year or two, learning almost nothing about the complicated work that they are supposed to supervise.
>
> Many of the witnesses ducked the dangerous problem of security. But a few eminent ones pulled no punches. President James R. Killian Jr. of Massachusetts Institute of Technology deplored "what sometimes seems to be a preoccupation with security procedures and policies at the expense of scientific progress. . . . There has been, unhappily, a deterioration in recent months in the relationship between Government and science. . . . Members of the scientific community are clearly discouraged and apprehensive. . . ."
>
> Said Mathematician John von Neumann of the Princeton Institute for Advanced Study, who last week was appointed to the Atomic Energy Commission . . .: "Very many people who have some trivial blot way back in their past do not know whether they can take a chance on getting into sensitive work. . . . To have once been dropped for security reasons is for the average person . . . a professional catastrophe."
>
> Most vehement about the capricious operation of the security system was Dr. Vannevar Bush, President of the Carnegie Institution and wartime chief of the Office of Scientific Research and Development. "I feel," said Bush, "that the way in which our security system is working at the present time is driving a wedge between the military and the scientific people of the country, and is doing great harm. . . . The whole air of suspicion is just not such as to produce . . . the kind of . . . collaboration between the military men and the scientific community that we very much need. . . ."
>
> To the worried scientists, the *Christian Century* offered its sympathy. "The unhappiness of our American scientists is increasing as they perceive how exposed is the position of one who is, in the last analysis, a tool of the Government. It may be necessary for scientists . . . to live under the eye of the FBI, but it is not pleasant.
>
> "Our public has been taught to think of him [the scientist] as a mental colossus and a moral paragon —austere, dedicated and all but beyond human vanities in his pursuit of the truth. . . . To this assumption of the scientist's moral superiority there has suddenly been added the social pre-eminence a society accords its workers of magic.
>
> "Under such conditions one might expect the scientist to be the most secure man in our society. He holds almost ultimate power—the power of life or death. But many an American scientist is . . . in moral torment. He has watched his science move from theory to human holocaust. . . .
>
> "Again many an American scientist is troubled because he finds himself dragged willy-nilly into a partisan conflict. . . . The scientist discovers that he is no longer the austere and impartial figure of popular legend and his own desires. Instead he is a partisan in a relentless battle for power. . . . The scientist who is engaged in atomic research for the Government has no stomach for such power struggles —but he cannot avoid becoming involved in them. . . . To protect his sanity he disavows moral responsibility for the consequences of his work. But does he convince himself?"

In a letter about **Nicolai Lunin** received recently by Clive McCay of Cornell University Agricultural Experiment Station, H. E. Voss of Mannheim-Waldhof Germany, writes:

> . . . In your article ["Gustav B. von Bunge," *J. Nutrition* 49, 1 (1953)] you cite on page 7 the thesis of Lunin, who, as you say, "disappears from the scientific stage after this one brillant appearance." It may be of interest for you that I have known Dr. Nicolai Lunin very well: he was a famous otolaryngologist at St. Petersburg and director of a clinic for this speciality till 1918, when he was replaced by a communist doctor on the order of the bolshevist government. As far as I know, he died at St. Petersburg in the year 1925 or 1926. He was married with the daughter of Gerta of the great botanist and mem-

ber of the Imperial Russian Academy of Sciences Maximowicz. The last years of his life he lived in very poor conditions at St. Petersburg. He was an excellent doctor, a great sportsman and hunter and a fine and generous man. Requiescat in pace! . . .

McCay had said in his paper that Von Bunge's interest in the composition of milk led to the attempts of his student, Lunin, to maintain mice with synthetic milk. The results of these studies appeared in Lunin's thesis in *Z. Physiol. Chem.* (1881), and through this work Von Bunge was convinced that milk contained organic essentials that the animal body could not make.

At a recent meeting of the American Bankers Association, Gwilym A. Price, president of the Westinghouse Electric Corp., said that **atomic power** is not going to upset the economics of the nation's electric utility industry. He cited three reasons why utilities need not worry about their investment in turbines, generators, transformers and other conventional equipment.

> In the first place, atomic power plants will use much the same equipment and facilities as coal-fired steam plants . . . the 'uranium boiler' will simply take the place of the coal boiler. The generators and transformers will be of the same types. The turbines may be essentially the same as those now being used.
>
> In the second place, the demands for electric power . . . will be so stupendous that every resource that is practical and available will be needed and used. Atomic power will enter the picture as another major source of energy, not as a replacement but as an essential supplement.

The third reason Price gave for anticipating the orderly approach to atomic power is that its widespread and extensive use for civilian purposes "is still some years away."

One of the most comprehensive surveys ever made of the health conditions of Arizona's Indians is published in the second annual report of the University of Arizona Bureau of Ethnic Research under the title, "**Indian health in Arizona.**" Prepared at the request of the Phoenix Area Office of the Bureau of Indian Affairs, the report was written by Bertram S. Kraus, university anthropologist. It covers approximately 26,540 Arizona Indians, including Papagos, Pimas, Colorado River Indians, Truxton Canyon Indians, and two Apache tribes. Some of the major findings of the survey are as follows:

1) Indians are less apt than whites to suffer from "constitutional" diseases such as cancer, allergies, metabolic and endocrine diseases, diseases of the circulatory and genitourinary systems, complications of pregnancy, and mental disorders.

2) Despite unhygienic living conditions, the survey produced the unanticipated finding that "environmental" diseases—infective, parasitic, respiratory, digestive, and nervous—show no higher frequency among Indians than whites.

3) When disease does strike, however, it produces a higher death toll among Indians than whites. This is due in large part to the fact that diseases remain undetected and untreated for a longer period among Indians. Indians live with their symptoms longer before seeking medical care, and hospitals and clinics are easily accessible only to villages in their immediate area. Indian cultural factors often cause reluctance to accept the white man's medicine.

4) The worst phase of the Indian health picture is the infant mortality rate which is at least three or four times greater than that of whites in Arizona. The biological process of the "survival of the fittest" is still the rule among the primitive Indian population. Only genetically sound individuals survive and propagate, which probably contributes to the favorable statistics in respect to the incidence of constitutional and environmental diseases. An improvement in living standards and a reduction of infant mortality might soon elevate the Indian health picture above the general U.S. level.

5) Arizona's Indian population is increasing steadily at a rate of 1 to 2 percent a year as a result of a birth rate that is considerably higher than the average for U.S. whites.

The Western Hemisphere is the part of the world in which **human population** is increasing most rapidly. Despite the general belief that Asia's population is growing fastest, United Nations experts who reported to the recent World Population Conference in Rome estimate that the 1.0 percent annual rate of increase on that continent is the lowest in the world. For the Americas, the estimate was 1.8 percent, with Latin America 2.2 percent, the latter a rate more than double that of Asia.

The population of Asia, however, probably will be between 1816 million and 2227 million by 1980, an increase of from 496 to 907 million, whereas the Americas will grow by 157 to 247 million to a total population of from 487 to 577 million.

Asian population, despite the fact that it is growing at a rate that is only a little more than one-half that of the Americas, is increasing far more rapidly because it starts with such a large population.

The U.N. demographers believe that the world population will jump from 2454 million in 1950 to a population in 1980 of between 3295 and 3990 million.

The first nests and the first egg of Trinidad's **Black-winged Bellbird** have been discovered in Trinidad. Named 137 yr ago by Georges Cuvier, French naturalist of the 18th and 19th centuries, the "bird with the fleshy beard"—so described because of the string-like outgrowths hanging from its throat—has managed to hide its nest, eggs, and mating habits all this time. Willam Beebe, director emeritus of the department of tropical research of the New York Zoological Society, found the first nest; 53 days later, Wilbur G. Downs, director of the Trinidad Regional Virus Laboratory, discovered a second nest and also the first egg.

Scientists in the News

President Eisenhower has named **John von Neumann,** research professor in mathematics at the Institute for Advanced Study at Princeton, N.J., to the Atomic Energy Commission. Von Neumann, whose work with a high-speed electronic calculator is credited with speeding the development of the hydrogen bomb, succeeds Eugene M. Zuckert, who resigned last June. The 5-yr appointment must be confirmed by the Senate. Von Neumann is a friend and associate of J. Robert Oppenheimer, whom he first met in Germany in 1926. When he testified at Oppenheimer's recent security hearings, Von Neumann said that he had no doubt concerning Oppenheimer's loyalty and that he did not consider him a security risk.

Von Neumann took issue, however, with the recent assertion of Vannevar Bush, president of the Carnegie Institution, that the wartime partnership between the military and science has been "almost destroyed" by the security program. "If anything, it is better," Von Neumann said of relations between the armed services and the scientific community. On 26 Oct. the *Washington Post-Times Herald* stated editorially:

> The President has chosen . . . a man of dazzling scientific brilliance and of great intellectual fertility. Dr. John von Neumann ranks unquestionably among the half dozen leading theoretical mathematicians in the world today. . . .
>
> Although Dr. von Neumann has kept himself in the main quite clear of political controversy, he was one of the important witnesses in the Oppenheimer case. His testimony there in behalf of Dr. Oppenheimer reflected an independence and integrity which bespeak additional fitness for membership on the AEC. . . . Von Neumann has suggested judicial procedures for security cases, expressing a thoughtful concern for individual rights. Probably the President chose him for the AEC post in part with the hope that his appointment would be reassuring to the disillusioned and dismayed scientific community. . . . It is an exemplary appointment in every respect.

To fill Von Neumann's place on the AEC General Advisory Committee, the President has appointed **Edwin Mattison McMillan,** physics professor at the University of California. He also named to this committee **Warren Charles Johnson,** chairman of the chemistry department at the University of Chicago, and **Jesse Wakefield Beams,** professor of physics at the University of Virginia. These committee assignments are not subject to Senate confirmation; the terms expire 1 Aug. 1960.

Harold Mazza, research process engineer for the American Potash and Chemical Corp. at its main plant at Trona, Calif., has been appointed assistant director of research for the company. He joined the firm in 1929 as a sampler in the control laboratory.

Hans B. Jonassen, professor of chemistry at Tulane University who has made contributions in the fields of drugs, foods, dyestuffs, agriculture, and petroleum through his researches on complex ions, has received the 1954 Southern Chemist award of the American Chemical Society's Memphis Section. The gold medal is given annually for distinguished service to chemistry in the Southern states.

Norman R. Davidson, associate professor of chemistry at California Institute of Technology, has received the 1954 California Section award of the American Chemical Society. He was honored for his development of techniques for measuring the speed of very fast chemical processes such as those that take place in high explosives and rocket propellants.

After a 2 yr leave of absence, **William Walter Greulich** has returned to his post at Stanford University, where he is professor and executive head of the department of anatomy in the School of Medicine. As a reserve officer in the foreign service, he has been serving as science adviser to the U.S. High Commissioner for Germany and as chairman of the Fulbright Commission in that country.

Fred L. Soper, director of the Pan American Sanitary Bureau, Regional Office of the World Health Organization, was reelected director for a third 4-yr term at the 14th Pan American Sanitary Conference that took place recently in Santiago, Chile.

Cornell University has announced that **Chandler Morse** of the economics department has been named director of the university's Social Science Research Center. He succeeds **Robin M. Williams, Jr.,** professor of sociology, who will spend the next academic year at the University of Oslo on a Fulbright grant.

Werner Heisenberg, 1932 Nobel prize winner in physics and head of the Max Planck Institute for Physics in Berlin, recently lectured on the multiple production of mesons at New York University's College of Engineering.

The Bonn government has appointed Heisenberg to survey the establishment of a nonmilitary atomic research center that is scheduled to go into operation after it is approved by the Allied High Commission.

Linus Pauling, chairman of the division of chemistry and chemical engineering at the California Institute of Technology, has won the 1954 Nobel prize for chemistry. He is the discoverer of the fundamental principles determining the nature of chemical bond and the structure of molecules, particularly of protein molecules. Because of charges made against him before a Senate investigating committee, the State Department in 1952 refused Pauling a passport to attend a chemical society meeting in London on the grounds that his participation was "not in the best interests of the United States." The refusal was withdrawn subsequently, and Pauling lectured in Europe.

The physics prize has been awarded to two German scientists, **Max Born** of Bad Pyrmont, Hanover, who until recently held a chair in mathematical physics at Edinburgh University, and **Walther Bothe,** since 1934

head of the Institute for Physics of the Max Planck Institute for Medical Research in Heidelberg. Born was honored "for his fundamental research in quantum mechanics, especially for his statistical interpretation of the wave function." Bothe won recognition for his coincidence method for measuring with extreme accuracy time-intervals in atomic processes.

John F. Enders of Harvard University, a recipient of the 1954 Nobel prize [*Science* **120**, 747 (5 Nov. 1954)] and of the annual Albert Lasker award, will present the 4th R. E. Dyer lecture at 8 P.M., 17 Nov., in the Clinical Center of the National Institutes of Health, Bethesda, Md. His subject will be "Recent observations on the behavior in tissue culture of certain viruses pathogenic for man." A cordial invitation is extended to the scientific public.

Meetings

The 3rd annual **Wire and Cable Symposium,** jointly sponsored by the Army Signal Corps Engineering Laboratories, Fort Monmouth, N.J., and by the wire and cable industry, will be held 7–9 Dec. at the Berkeley-Carteret Hotel, Asbury Park, N.J. Persons interested in communications and in wire and cable problems who wish to attend the symposium may obtain further details from H. L. Kitts, Coles Signal Laboratory, Fort Monmouth, N.J.

The second annual **symposium on antibiotics,** sponsored by the Food and Drug Administration, U.S. Department of Health, Education, and Welfare, in collaboration with the journal, *Antibiotics and Chemotherapy,* took place 25–29 Oct. 1954, in Washington. Under the chairmanship of Henry Welch, director of the division of antibiotics, Food and Drug Administration, advances in the field of antibiotics were reported by 172 speakers, including several from abroad. Ministers of health or their representatives from 31 foreign countries were invited to attend.

Guest speakers on the opening day included Selman A. Waksman, Nobel prize laureate and discoverer of streptomycin, Felix Marti-Ibanez, former Under Secretary of Health of Spain, and Maxwell Finland and Theodore Woodward, two leading scientists in the field of antibiotics. One day was devoted to the newest of the broad spectrum antibiotics, tetracycline, and another to new antibiotics, some of which were described as having antitumor and anticarcinogenic activity.

The **Society for Industrial and Applied Mathematics** will hold its first national meeting in conjunction with the annual meetings of the American Mathematical Society, the Mathematical Association of America, and the Association for Symbolic Logic at the University of Pittsburgh, 27–29 Dec. The following addresses will be presented to an evening meeting: "The history of a problem," Brockway McMillan, Bell Telephone Laboratories; "Control of industrial operations," Herbert A. Simon, Carnegie Institute of Technology; "Probability theory in liability and property insurance," C. W. Crouse, Actuary, Preslan and Co. Further information may be obtained from H. W. Kuhn, Dalton Hall, Bryn Mawr College, Bryn Mawr, Pa.

The 2nd annual congress of the **Interamerican Society of Psychology** will be held at University City, Mexico, 14–19 Dec. The central theme will be *Psychology of Education,* from the aspects of applied psychology, psychotherapy, social anthropology, and teaching. A limited number of guest accommodations will be available at the National University of Mexico; a larger number will be available at nearby hotels. However, since the demand for accommodations is sure to exceed the supply, interested persons are urged to apply immediately for membership in the congress. A curriculum vitae in triplicate should be sent to the general secretary, Werner Wolff, Bard College, Annandale-on-Hudson, N.Y.

Education

H. D. Bruner, professor of physiology at Emory University, will join Marcelo Alonso, professor of physics at the University of Havana, and Ovidio de Laosa, director of the Radioisotopes Laboratory at Curie Hospital, in presenting a course on the **uses of radioisotopes** to 24 scientists from Latin American countries. The course, under the sponsorship of UNESCO, will be held during December at the **University of Havana.**

Reed College of Portland, Ore., has entered a cooperative "3–2 plan" with **California Institute of Technology** in which students from Reed will be admitted to the institute as juniors after 3 yr of study in a special program. After the student successfully completes 2 yr at the institute, he will be awarded the bachelor of arts degree by Reed and the bachelor of science degree by the institute.

Four liberal arts colleges are now cooperating with Caltech in this plan—Reed, Occidental, Pomona, and Whitman. The plan may be extended to other schools.

West Virginia University has announced that excavation is now underway for the construction of the Basic Sciences Building of the new University Medical Center in Morgantown. The building will contain more than 1000 rooms and will provide quarters for instruction in the preclinical years in medicine, nursing, and medical technology, as well as facilities for dentistry and pharmacy.

The new medical center will be located on a 145-acre tract within the city limits of Morgantown and approximately 2 mi from the main campus. Essentially complete is the $1,070,719 mechanical plant which will supply heat, power, and other services. The teaching hospital, which will contain 400 beds initially and will be joined to the Basic Sciences Building, is in the planning stages now.

Available Fellowships and Awards

The **School of Mathematics of the Institute for Advanced Study,** Princeton, N.J., will allocate a small number of grants-in-aid to gifted young mathematicians and mathematical physicists to enable them to study and to conduct research at Princeton during the academic year 1955–56. Candidates must present evidence of research ability comparable at least with that expected for the Ph.D. degree. Application blanks may be obtained from the School of Mathematics. *They must be returned by 1 Jan. 1955.*

Applications for grants for scholars in cancer research are being accepted by the Committee on Growth of the National Research Council, acting for the **American Cancer Society.** These awards are designed to bridge the gap between the completion of fellowship training and the period when the young scientist has thoroughly demonstrated his competence as an independent investigator. A grant of $18,000, payable over 3 yr, will be made to each scholar's institution as a contribution toward his support, his research, or both. Each institution may submit more than one application. *The deadline is 1 Jan. 1955.* These grants are not restricted to the support of individuals who have held American Cancer Society fellowships. Application blanks and additional information may be obtained from the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Ave. NW, Washington 25, D.C.

The **Social Science Research Council** has announced the fellowships, grants-in-aid, and other appointments that it is supporting in 1955. Most of the awards are offered at only one stated time during the year, and closing dates vary, beginning in Jan. 1955. Preliminary inquiries and requests for application forms, indicating age, place of permanent residence, academic status, vocational aims, the nature of the proposed training or research, and the type of assistance desired, should be made as early as possible, so that there may be ample time for careful consideration in advance of formal action. All communications should be addressed to The Social Science Research Council, 726 Jackson Place N.W., Washington 6, D.C.

In the Laboratories

The **Armour Research Foundation** of the Illinois Institute of Technology, Chicago, has announced plans for what is said to be the first nuclear reactor for industrial research. The reactor, or atomic pile, will cost about $500,000. The foundation will assume about one-third of the investment, and industries in the Chicago area are being invited to participate with subscriptions of $20,000 each.

The proposed facility with a power equivalent to 50,000 w will be a highly flexible neutron and gamma source and is not intended for research on reactors themselves or for the generation of electrical power. Rather, it will be designed for investigations into such fields as sterilization of foods and drugs; high polymer studies of the structure of plastics, rubber, and other materials; development of metals and alloys; and medical techniques. The reactor will be housed in a new 8000-ft² building on the institute's campus. Plans are being submitted to the Atomic Energy Commission.

The **Trudeau Sanatorium** will close its patient-care facilities on 1 Dec. Founded in 1884 as the Adirondack Cottage Sanatorium by Edward Livingston Trudeau, who himself had tuberculosis, the Trudeau Sanatorium, renamed upon his death in 1915, is the nation's oldest private institution for the treatment of this disease. The Trudeau-Saranac Institute, which has operated the sanatorium, will continue and will increase its research activities in tuberculosis and other chest diseases, particularly those of industrial origin such as silicosis, asbestosis, beryllium poisoning, and lung cancer.

The decision to close the institution, which has given care to more than 12,000 patients, has a significance for the Saranac Lake community beyond the effect on its economic future. Nearly one-third, and at one time one-half, of the 6700 residents originally settled in the area because of personal health problems, primarily tuberculosis. Once having "taken the cure" successfully, they built their lives and their community around this disease.

A special committee has been appointed to study the possibilities of using the sanatorium's facilities, consisting of over 50 buildngs on a 100-acre plot, for other health purposes.

A new $1,500,000 sound laboratory having one of the largest known anechoic chambers was officially dedicated in October by the **General Electric Co.'s** power transformer department at Pittsfield, Mass. With the new facility, G.E. hopes to eliminate the problem of transformer noise. Transformers rated 500,000 kva or higher can be tested in this laboratory. The anechoic chamber, which is about as high as a four-story building, was built for a 30 to 40 db ambient sound level; tests have shown the sound level in the chamber to be less than 20 db.

The **Westinghouse Electric Corp.,** Pittsburgh, has announced the formation of a new products engineering department to be headed by W. H. Brandt. Work of the new department will be closely coordinated with that of the research laboratories and the materials engineering department.

General Motors Research Laboratories has announced plans to use radioactive isotopes in peacetime engineering and research studies. The program will include construction of a new laboratory at the General Motors Technical Center north of Detroit. Work will be confined to isotope research, the so-called tracer studies—not research in nuclear physics or engineering of atomic piles for power.

Book Reviews

Graphics in Engineering and Science. A. S. Levens. Wiley, New York; Chapman & Hall, London, 1954. viii + 696 pp. Illus. $7.

Graphics in Engineering and Science is unique in that it embraces in one volume three distinct aspects of graphical expression. The author has, therefore, properly divided the book into three parts. Part I deals with the fundamental principles of projection, or what may be termed the grammar of graphical language; part 2, on drawing practices, shows methods of expression in that language; part 3 is concerned with the coordination of graphics with the language of symbols in the solution of problems in mathematics and physics. It is felt that the book can best be reviewed by treating the three divisions separately.

Part I, "Fundamentals and applications of orthogonal projection," consists of material that in general may be found in any modern textbook on descriptive geometry. The nomenclature has been modernized so that it is almost completely divorced from Mongean terminology. The author has perhaps gone too far in this direction. For example, the terms *grade* and *bearing* used in defining lines, are not too fitting when they are applied to problems in machine design.

The treatment of visibility as a separate chapter (chap. 6) is excellent. The importance of reading is not emphasized enough in most textbooks.

There is not enough space devoted to problems in rotation about line axes. The use of supplementary projections on two adjacent coordinate planes is not always practical from the standpoint of working space. A solution by means of a rotation and perhaps one supplementary plane may be completely satisfactory and occupy far less space.

In part 2, "Technical drawing practices," the presentation, illustrations, and exercises are good. The material conforms to the most modern A.S.A. standards and practices. Sections, conventions, thread forms, fasteners, cams, and gears are admirably presented. There is adequate space devoted to dimensioning. The treatment of limit dimensioning is particularly well handled.

In part 3, "Graphical solutions and computations," Levens performs a distinct service in pointing up the value of graphical solutions to various types of problems encountered by engineers. The explanations of charts and nomographs and methods of setting up graphic scales for the solution of mathematical equations are succinctly and lucidly expressed.

The force diagrams in the chapter on "Graphic statics" are exceptionally good. The use of orthogonal projection in the solution of concurrent noncoplanar force systems is very well presented.

Not the least valuable section of Levens' book is the large appendix with its wide range of factual material and its carefully selected bibliography.

Graphics in Engineering and Science goes beyond its basic function as a textbook for college courses. It has an important function as a reference book in practical design and research.

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***The Genus* Euglena.** Mary Gojdics. Univ. of Wisconsin Press, Madison, 1953. 268 pp. Illus. $6.50.

Mary Gojdics' monograph meets a need long felt by students of the genus *Euglena*. It includes a general discussion of the morphology and cytology of the genus, an artificial key to the species, a description of each species with original drawings by the author or reproductions of illustrations from original descriptions of the species, an annotated check list, and a complete bibliography to the taxonomy. The annotated check list of *Euglena* and citations to the literature are significant contributions to workers in the field, new and old.

The key to the species, based on the characteristics of the chloroplasts, is well thought out but, as in the case of most keys, it will be effective only in the hands of the expert. Cytologic procedures are often necessary before the chloroplast structure can be discerned. The initiate in protozoology or algology will be able to use the descriptions and illustrations for species identification.

The author has been effective in fusing her observations with those described by others. Her interpretations appear to be valid in light of the present literature. Future publication will undoubtedly clarify some of the cases of speciation and synonymy discussed.

A second monograph on the physiology of the genus and its taxonomic implications is needed. Until this appears, the present morphologically centered work is a fitting and an excellent initiation to our present knowledge of the taxonomy of the group and a noteworthy contribution to the field.

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Artificial Fibres. R. W. Moncrieff. Wiley, New York, ed. 2, 1954. xii + 455 pp. Illus. $6.

The author is well known for his achievements in the synthetic fiber field and for his wide experience. The book, now in its second edition, attempts to introduce the outsider to the fundamental and technologic aspects of "artificial" fibers—that is, fibers prepared by man from natural or synthetic polymers. At the same time, some technologic information of interest to the specialist is offered. In spite of such conflicting tendencies, Moncrieff has solved the problem in a very competent manner. He has succeeded in presenting clearly

the results of one of the most important branches of polymer chemistry and their practical application in the textile industry.

The book comprises five parts, subdivided into 37 chapters. The first part deals briefly with the fundamentals of fiber structures and serves as an introduction to the problems involved in fiber formation. Parts II and III describe fibers based on natural polymers (cellulose, alginates, and proteins). Part IV covers the truly synthetic fiber types (polyamides, polyesters, polyurethanes, vinyl, and acrylic fibers) as well as glass and coated fibers. The last part contains in condensed form some information on processing, including its analytic and economic aspects.

Moncrieff had to deal with a complex, widely branched field in which some technical information is withheld by the manufacturing interests involved. In a few instances, he has attempted to lift the veil by doing some guesswork. Although he was not particularly successful in some cases (for example, composition and melt spinning of an acrylic fiber, pp. 327–9), in other cases his predictions have proved to be correct (for example, elimination of fibrillation in another acrylic fiber, p. 326).

The book is well printed and contains literature references at the end of each chapter. The addition of an author index would be welcome. The present index does not contain all the authors' names.

Artificial Fibres can be warmly recommended to the student. The specialist will find it a valuable reference.

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The Chemstrand Corporation

Diagnosis and Improvement of Saline and Alkali Soils. U.S. Salinity Laboratory Staff; L. A. Richards, Ed. U.S. Dept. of Agriculture, Washington, D.C., rev. ed., 1954. vii + 160 pp. Illus. $2. (Order from Supt. of Documents, GPO, Washington 25, D.C.)

This is an enlarged, printed, hard-cover revision of the 1947 multilithed edition. It is written for the professional agricultural worker and provides an excellent discussion of the major problems associated with the characterization, improvement, and management of alkali soils for crop production. The first five chapters provide a basis for the evaluation and interpretation of measurements. Chapters 6, 7, and 8 present procedures and measuring methods in use at the U.S. Salinity Laboratory. No attempt is made to present methods from other sources, irrespective of their suitability. In many cases the handbook covers alternate methods of analysis, and the worker can select from these, depending on the equipment available and the accuracy of results desired. Each description of a method of analysis includes, when applicable, sections on apparatus or equipment, reagents, procedures, remarks, calculations, and references. More than 100 separate methods are discussed under the broad headings of soil characterization, plant culture and plant analysis, and analysis of irrigation water. Diagrams and charts are used extensively throughout. Although the publication deals specifically with alkali soils and the problems related to their use, the methods of analysis are applicable for broad use in the fields of soil chemistry and physics, plant physiology, and drainage engineering.

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Catalysis. vol. I. *Fundamental Principles* (pt. I). Paul H. Emmett, Ed. Reinhold, New York, 1954. 394 pp. Illus. $10.

In the past catalysis has been an important art, but within the last 30 years it has acquired a coating of scientific luster composed of all the research tools of science. The present series attempts to record in orderly fashion what is now known in regard to theory and practice. The chapter titles in order are "Physical adsorption," by Herman E. Ries, Jr.; "Measurement of the surface area of solid catalysts," by Paul H. Emmett; "Chemisorption," "Kinetic laws in surface catalysis," and "The absolute rates of surface reactions," all by Keith J. Laidler; "Catalyst carriers, promoters, accelerators, poisons, and inhibitors," by W. B. Innes; "Catalyst preparation," by F. G. Ciapetta and C. J. Plank; "Magnetism and catalysis," by P. W. Selwood.

The first two chapters give a pithy and well-organized résumé that will be useful to anyone interested in the subject. On reading chapters 3 and 4, I was struck by how much was accomplished by I. Langmuir in 1918, how his principal ideas still dominate the field, and how few new ideas about fundamental physical pictures have since been presented, even though the basic theory now appears in more erudite terms. Chapters 4 and 5 contain little that has not been previously explored in detail in many books.

One wonders if the dressing up of kinetic equations in terms of partition functions represents a real advance when, in the present state of knowledge, the component factors either have to be assumed or depend upon measurement of quantities that occur in the simpler forms.

Chapters 6 and 7 furnish much practical information on the morphology of catalysts and their preparation. Although reaction rates are markedly insensitive to magnetic influences as opposed to electrostatic influences, nevertheless, magnetic susceptibilities often do give information in respect to state of oxidation of the catalyst that cannot be obtained in any other way. The importance of magnetic analysis is just beginning to emerge.

My chief regret is that the editor did not write some of these chapters himself. A better result would have been obtained.

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Technical Papers

Laboratory Preparation of $Ca^{45}CO_3$ and $Ca^{45}SO_4 \cdot 2H_2O$

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Calcium chloride labeled with calcium-45 can be purchased from certain suppliers under Atomic Energy Commission authorization. This is reasonably priced and is readily available. On occasion, however, salts such as calcium carbonate and gypsum labeled with calcium-45 may be required quickly for experimental work These labeled salts may be more conveniently referred to as $Ca^{45}CO_3$ and $Ca^{45}SO_4 \cdot 2H_2O$. Combining calcium-45 from a calcium chloride source with gypsum or lime to give a calcium-45 labeled product is not a novel procedure. However, considerable expense and time can be saved, and maximum yields of $Ca^{45}CO_3$ and $Ca^{45}SO_4 \cdot 2H_2O$ are possible using procedures outlined in this paper (*1*).

There are a few reports in the literature describing methods for these conversions. Where yield data are given, they indicate that calcium-45 is being inefficiently recovered owing to incomplete precipitation. This applies particularly to reports outlining the preparation of $Ca^{45}SO_4 \cdot 2H_2O$.

Blume and Hall (*2*) prepared $Ca^{45}CO_3$ by adding $Ca^{45}Cl_2$ to a solution of calcium nitrate and heating to 80°C. Precipitation was accomplished by adding a 2-percent solution of ammonium carbonate and 2 to 3 ml of ammonium hydroxide. The vessel was closed and the contents were digested for several hours. Harris *et al.* (*3*) prepared $Ca^{45}CO_3$ by precipitating a solution of radiocalcium and calcium chloride with carbon dioxide under pressure.

Robertson and Blume (*4*) labeled gypsum with radiocalcium by dissolving calcium sulfate in hot (1+3) nitric acid and adding $Ca^{45}Cl_2$ to this solution. The gypsum was crystallized out by cooling the solution. The yield was about 33 percent. Blume and Hall (*2*) prepared $Ca^{45}SO_4 \cdot 2H_2O$ by adding 10 percent sulfuric acid to a suspension of $Ca^{45}CO_3$ and heating and stirring this mixture for 6 to 8 hr. The product obtained was a mixture of anhydrite and gypsum.

For our study, calcium chloride tagged with calcium-45 was purchased (*5*) under Atomic Energy Commission authorization. Calculations were made to determine how much radioactive $Ca^{45}Cl_2$ was needed to supply the desired activity per unit weight of calcium in the finished product, whether $Ca^{45}CO_3$ or $Ca^{45}SO_4 \cdot 2H_2O$. Because this amount can be varied according to individual needs, the sequence of adding calcium-45 is indicated in the procedures rather than the actual amounts used.

Calcium carbonate. Labeled $Ca^{45}CO_3$ was prepared by dissolving a calculated weight of calcium chloride in (1+10) hydrochloric acid. For example, 8.8140 g of $CaCl_2 \cdot 2H_2O$ was dissolved in 40 ml of (1+10) hydrochloric acid and the solution was diluted to 300 ml. To this solution was added a previously determined amount of $Ca^{45}Cl_2$ and the solution was made alkaline with sodium hydroxide using phenolphthalein indicator. The $Ca^{45}CO_3$ was precipitated by adding 12 g of sodium carbonate to the solution. Experimentation showed that an excess of sodium carbonate was needed for complete precipitation. Twice the theoretical minimum amount necessary for precipitation was used. The resulting solution and precipitate was digested for 12 hr at 65°C and was allowed to stand overnight. The precipitate was filtered off on a No. 50 Whatman filter paper through a Buchner funnel and was dried at 70°C. The yield was 99.40 percent of the calculated weight that theoretically could be attained.

The purity of the product was determined by dissolving a weighed portion of the precipitate in dilute (3+100) HCl and titrating with versenate according to a modified method of Cheng and Bray (*6*). The purity of reagent calcium carbonate compared with that prepared in the laboratory is shown in Table 1. There was a high rate of activity recovery, as is shown in the table.

Calcium sulfate. Labeled $Ca^{45}SO_4 \cdot 2H_2O$ was prepared by dissolving analyzed calcium chloride in water. The amount of calcium chloride used depended on the weight of product required. Similarly the amount of $Ca^{45}Cl_2$ used depended on the specific activity—that is, millicuries per unit weight—desired. For example, 5.0 g of calcium chloride was dissolved in 50 ml of water containing the desired amount of $Ca^{45}Cl_2$, and 50 ml of water containing 10 ml of sulfuric acid was added to this solution. Experimentation showed that an excess of sulfuric acid was needed for complete precipitation. Four times the theoretical minimum necessary

Table 1. Purity of preparations and recovery of added calcium-45.

Source of $CaCO_3$ and $CaSO_4 \cdot 2H_2O$	Purity of product (%)	Recovery of Ca^{45} in product* (%)
$CaCO_3$ reagent	99.93	
	100.00	
$CaCO_3$ laboratory preparation	99.59	96.6
	99.72	97.3
	99.75	96.5
	99.51	98.1
$CaSO_4 \cdot 2H_2O$ reagent	99.82	
	99.50	
$CaSO_4 \cdot 2H_2O$ laboratory preparation	99.43	96.5
	99.20	97.8
	99.10	98.4
	99.22	98.8

* 0.2 μc Ca^{45} added to each sample.

for precipitation was used. Precipitation was completed by adding 110 ml of 95-percent ethanol. The mixture was digested on a steam bath for 34 hr, cooled, and filtered on a No. 50 Whatman filter using a Buchner funnel. The precipitate was washed free of chlorides with 95-percent ethanol and was then allowed to stand in 95-percent ethanol for 1 hr. The ethanol was filtered off and the precipitate was dried in a vacuum oven (25 in.-of-water) for 1 hr at 80°C. Yields of 99 percent or better are possible by this technique, as is shown in Table 1. The rate of activity recovered was also high.

Drying procedure and time appear to be critical factors in this procedure. In trials where the filtered and washed product was dried for 48 hr at 70°C, analyses showed that the product was dehydrated gypsum, $CaSO_4 \cdot 1/2H_2O$. This product was then converted to gypsum by digestion with water on the steam bath for 3 hr and drying in a vacuum oven (25 in.) overnight at 52°C.

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Effects of Narcotics on Coenzyme-A Activity in Acetylation

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There is, as yet, no definitive evidence relative to the primary site of action of narcotics in biological systems. Whether the effective mechanisms are related to the physiological membrane, to intracellular biochemical processes, or to both remains to be determined. A number of investigations have indicated the possibility, once the narcotic is inside the cell, of interference with certain events in the respiratory cycle. The most recent concepts suggest a relationship to the synthesis and utilization of adenosinetriphosphate (ATP) (*1*). The utilization of both ATP and coenzyme A (coA) is essential in the synthesis of acetylcholine. Since acetylcholine formation has been shown to be inhibited in narcotized systems (*2, 3*), the present investigation (*4*) was undertaken in order to examine the possible effects of narcotics on coA and ATP utilization in a "pure," direct acetylating system.

The acetylation system selected for use in this study is that described by Kaplan and Lipmann (*5*). This system was specifically chosen because of the high degree of quantitation of its elements and the purity of assay it allows. Pigeon liver extract was prepared and aged as described by Kaplan and Lipmann. It is of particular importance that this extract contains extremely low concentrations of adenosinetriphosphatase (ATPase). Coenyzme A was obtained from the Nutritional Biochemical Co. This material is approximately 75-percent pure, containing (by enzyme assay) more than 20 percent of pantothenic acid and only 0.03 μM/mg of inorganic phosphate. It was used in three forms: freshly prepared from the desiccated powder; freshly prepared from desiccated powder kept at room temperature for 2 mo; and after having been kept frozen in aqueous solution at −20°C for periods of 1 to 4 wk.

The concentrations of coA are expressed in terms of a unit defined as the amount of the coenzyme per milliliter of solution that will activate the system to one-half of the maximum activity. One unit is equal to 0.025 mg of coA per milliliter of solution. The concentration-activity curve for our system paralleled that of Kaplan and Lipmann, except for a moderately higher degree of acetylation per unit. The coA assay reaction mixture and the contents of the *control* reaction tubes and blanks were identical with those of Kaplan and Lipmann.

To each of the experimental tubes the narcotic of choice was added in the concentrations shown in Tables 1 and 2. All reactions were carried out in air, in tubes of 1.1-cm outside diameter. Reaction time was 2 hr at 37°C. The reaction was stopped by the addition of 4 ml of 5 percent trichloracetic acid to each tube. Sulfanilamide was determined by the method of Bratton and Marshall (*6*), by using a Rouy colorimeter with a 550-mμ filter. The difference in sulfanilamide between the blank and the coenzyme-containing tubes represents the amount of sulfanilamide acetylated.

In this "pure" direct acetylating system, the degree of acetylation of sulfanilamide is a function of the number of units of coenzyme A added up to concentrations that give maximal activity. The initial quantities of adenosinetriphosphate and acetate are known, and the utilization of both is required in order that the reaction proceed. It can be seen from Table 1 that the percentage of sulfanilamide acetylated increases with increasing amounts of the coenzyme but is *not* affected by the addition of chloretone (3 mM). The data presented in Table 2 show a similar lack of effect on the acetylation mechanism by a series of other narcotics. In other words, the narcotics have no effect on the rate of sulfanilamide acetylation measurable with these techniques, under these conditions. It is of interest that the concentrations of narcotic used here are high enough to affect both the rate of oxygen consumption and the response to stimulation of nervous tissue in sympathetic ganglion and brain.

It can be concluded from the present experiments that, in this system, coenzyme A is not blocked by the narcotic. The lack of interference with acetylation leads to the inference that ATP utilization is not disturbed.

The reported pentobarbital inhibition of Govier and Gibbons (*7*) was not observed in the present series of experiments. It is suggested that two possible factors may have been responsible for their observation: (i)

Table 1. Effects of chloretone on direct acetylation. All reaction tubes contained solutions as described by Kaplan and Lipmann (*5*) in addition to coenzyme A and/or narcotic.

Reaction mixtures	Blank No coA or chloretone	Control I 1 unit coA	Experimental I 1 unit coA, 3 mM chloretone	Control 2 2 units coA	Experimental 2 2 units coA, 3 mM chloretone	Control 3 4 units coA	Experimental 3 4 units coA, 3 mM chloretone
Sulfanilamide (γ)	57	27.8	28.2	10.3	10.3	9.3	9.3
Acetylated sulfanilamide (γ)		29.2	28.8	46.7	46.7	47.7	47.7

Table 2. Effects of narcotics on direct acetylation. Control values obtained for each experiment were the same and did not very significantly. All reaction tubes contained solutions as described by Kaplan and Lipmann (*5*) in addition to coA and narotic.

Solution Reaction mixtures	Blank No coA or narcotic	Control 1 unit coA	Pentobarbital 1 unit coA, 3 mM pentobarbital	Secobarbital 1 unit coA, 3 mM secobarbital	Chloral hydrate 1 unit coA, 3 mM chloral hydrate	Phenobarbital 1 unit coA, 3 mM phenobarbital	Paraldehyde 1 unit coA, 3 mM paraldehyde
Sulfanilamide (γ)	56	28	28	27	27	28	28
Acetylated sulfanilamide (γ)		28	28	29	29	28	28

the source of coA (*8*); and/or (ii) the presence of split products in the reaction mixture. In the light of the Kaplan-Lipmann (*5*) curve of coA activity per unit, it is difficult to understand why Govier and Gibbons did not obtain a much more marked difference in their system (with 3 mM of pentobarbital), following addition of 5 units of coA.

Consequently, our findings prevent agreement with the postulate of McLennan and Elliott (*3*) that narcotic drugs act by inhibiting direct acetylating systems. Thus far, our results using a *"pure" system with added coenzyme A* are in accord with the observations of Johnson and Quastel (*1*) using *cell-free extracts*. However, a pure system is necessary to determine whether the narcotic action is on the ATP-coA acetate reaction (*9*). Comparison with the studies of Johnson and Quastel reveal that their preparations of cell-free extracts contained *unknown* amounts of ATP and coA. These values must be known in order to separate possible narcotic action on ATP utilization and coA inhibition from interference with high-energy phosphate bond synthesis or production. If ATP synthesis is decreased in a narcotized system, quantitative measurements of ATP should be made, and such studies are in progress. The initial results have been reported recently (*10*).

A system is described for the effects of narcotics on a "pure" *in vitro*, direct acetylating system containing known amounts of adenosinetriphosphate and coenzyme A. No interference with the acetylation—that is, no disturbance of either coenzyme-A activity or ATP utilization—was observed following addition to the system of chloretone, phenobarbital, pentobarbital, secobarbital, chloral hydrate, and paraldehyde. These findings are discussed in relation to those reported in other *in vitro* systems.

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24 June 1954.

Folic Acid Deficiency in the Dog

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It has been stated (*1*) that dogs do not need folic acid preformed in the diet, and the synthetic diets currently in use do not contain this vitamin as supplement. Krehl and Elvehjem (*2*) found that a "folic acid" concentrate derived from liver extract enhanced the response to niacin in niacin-deficient dogs. Similarly, Krehl *et al.* (*3*) observed that synthetic *L. casei* factor improved the response to standard doses of niacin in niacin-deficient dogs, and that this factor also seemed to play a role in maintaining a more adequate blood picture in these animals. However, Ruegamer *et al.* (*4*) found that, although folic acid was effective in bringing about a more consistent response

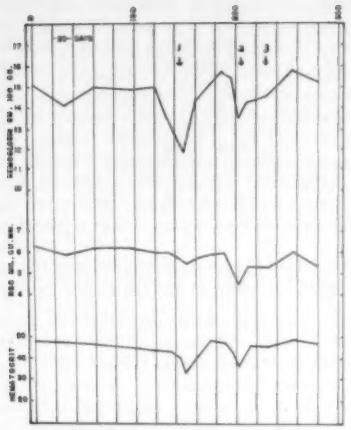

Fig. 1. Blood changes in folic acid deficiency: *1*, 30 mg folic acid; *2* and *3*, 15 mg of folic acid.

in weight in niacin-deficient dogs, it had no apparent effect on the anemia that developed progressively.

Folic acid deficiency was observed in this laboratory (*5*) in one of the control dogs used in nutritional studies that was consuming the following diet: basal ration consisting of vitamin test casein (GBI) 18.0, sucrose 68.0, vegetable oil (hydrogenated) 10.0, salt mixture USP XIV 4.0, and bone ash 4.0 g; vitamin supplements (GBI) per kilogram of body weight per day consisting of thiamine HCl 0.05, riboflavin 0.10, nicotinic acid 0.50, ca-pantothenate 0.22, pyridoxine HCl 0.04, choline chloride 0.20, inositol 0.50, p-aminobenzoic acid 0.50 mg, vitamin A 200 IU, vitamin D 10 IU, alpha tocopherol 1.0, and 2-methyl-naphthoquinone 1.0 mg.

The control animal, a 2-yr old mongrel female dog, started to lose weight soon after being placed on the synthetic ration, and by the end of the experimental period (278 days) had lost 12.5 percent of the initial weight (1.9 kg). At no time did it develop diarrhea or loose stools. The feces remained dark brown and hard in contrast to the grey and rather soft feces of the control dogs receiving similar diet. The hematocrit values showed a progressive and steady decrease (Fig. 1). The possibilities of iron, choline, vitamin B_{12}, or folic acid deficiencies were considered. The following curative measures were instituted: iron and ammonium citrate in doses of 250 mg, later increased to 500 mg, was given orally daily for 3 wk (45th to 60th day); choline chloride, 50 mg/kg body weight per day, was given by mouth for 2 wk (65th to 80th day); a single dose of 30 μg of vitamin B_{12} (*6*) was administered subcutaneously (84th day). Finally, the dosage of B vitamin supplements was doubled (102nd day).

By the 152nd day, when the last procedure was still in progress, the hemoglobin concentration decreased 39 percent, and the hematocrit value dropped from 49 to 33 percent (Table 1). The blood smears revealed hypochromia, moderate anisocytosis, and a few basophilic erythrocytes. At this time 30 mg of folic acid (*7*) was administered subcutaneously into the shoulder region. The response was prompt, and the blood values returned to normal within 14 days. However, they soon started to decline again.

The second attack, which occurred on the 200th day, was similar to the first. During both attacks the amount of folic acid required to bring about the maximum response was 0.015 mg/kg body weight per day. During the first attack the regeneration of hemoglobin amounted to 0.24 g/kg body weight per day, and during the second attack it was 0.22 g/kg.

During the attacks the animal did not appear sick but lacked the usual vivacity. The feces remained normal. The tongue assumed a bright red color, and small atrophic areas appeared on the dorsum (*8*). The plasma volume remained constant throughout the experimental period. The cell volume exhibited fluctuations corresponding to the variations in the hematocrit values (Table 1). The white cell counts decreased from 10.0 ± 2.9 to 8.1 ± 2.1 thousand.

During the preliminary observation period (Purina chow with 50 percent horse meat added) the total acidity of the histamine stimulated gastric juice was 99.0 ± 16.4 milliequivalents, and during the experimental period it was 92 ± 15.4 milliequivalents. In the control dogs using the same diet it was 96 ± 9.5 and 111.0 ± 5.0 milliequivalents, respectively. There was no change in the volume (40.5 ± 9.5 ml) or in the *p*H range (1.2–1.4) of the juice.

Table 1. Blood findings in a folic acid-deficient dog and response to folic acid administration.

	Days	Weight (kg)	Hemoglobin (g/100 ml)	Hemoglobin (g/kg body weight)	Red cells (mm^3)	Hematocrit (%)	Mean corpuscular volume (μ^3)	Plasma (% body weight)	Cells (% body weight)
Before	0	15.2	15.1	13.0	6.0	49.0	82	4.3	4.3
Attack	153	13.8	11.8	7.9	5.5	33.0	60	4.5	2.2
Response*	174	14.1	15.8	12.8	5.8	49.0	84	4.3	4.0
Attack	200	13.7	13.4	8.8	4.3	36.0	83	4.2	2.4
Response*	210	13.9	14.5	12.0	5.2	46.0	88	4.4	3.8

* 0.015 mg of folic acid per kilogram of body weight per day.

The autopsy revealed hypoplasia of the bone marrow and lingual lesions characterized by epithelial proliferation associated with papillary atrophy and nerve degeneration (*8*). The liver was normal.

On the basis of the foregoing observations, folic acid was administered to niacin-, riboflavin-, pyridoxine-, and pantothenic acid-deficient dogs. Given alone, it failed to bring about any observable effect; nor did it enhance the response to the administration of niacin, riboflavin, pyridoxine, and pantothenic acid in the deficient dogs. Similarly, it did not have any effect when it was given to the control animals.

It appears that some dogs may require folic acid preformed in the diet. The deficiency syndrome is characterized by hypoplasia of the bone marrow, hypochromic anemia with a tendency to microcytosis, and glossitis.

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Application of Mercury-Intrusion Method for Determination of Pore-Size Distribution to Membrane Filters

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The mercury-intrusion method for determining pore-size distribution is a dilatometric method (*1*) based on the employment of external pressure to overcome the forces of surface tension which prevent the entrance of the nonwetting liquid mercury into the pores of an immersed sample (*2*). The equation

$$pr = -2\sigma \cos\theta \qquad (1)$$

relates the applied pressure p to the radius r of a circular aperture through the coefficient of surface tension σ of mercury and its contact angle θ with respect to the material under test. Recent reports from this laboratory (*3*) have presented the results of the application of this method to cotton textile materials (*4–6*), assuming values for σ and θ that reduce Eq. 1 to

$$pr = 105.6, \text{ lb } \mu/\text{in.}^2, \qquad (2)$$

where p is the absolute pressure (lb/in.^{2}) and r is in microns. In this report, these assumptions are examined in the light of the data obtained on hydrosol-type membrane filters whose pore-radius dimensions presumably lie within a limited range.

These filters have been described as highly porous cellulose ester structures containing numerous uniform and submicroscopic channels, whose apertures on the upper surface of the filters are smaller than those on the lower surface, and whose pore size can be controlled in the manufacturing process (*7–11*). The particular variety used for this experiment was Millipore Filters, Type HA (hydrosol assay) (*12*), which have been shown to retain particles as small as 0.3 to 0.5 μ in diameter dispersed in water (*13*). Thus, the limiting radius of the smaller or upper aperture is set at 0.15 to 0.25 μ. From the reported frequency of pores per unit surface (*8, 11*), the limiting radius of the larger and lower aperture can be estimated to be 0.7 μ or less. Both dimensions are based on the assumption that the pores are approximately circular.

The specimens were taken from two different lots representing slightly different ranges with respect to manufacturing control, so that one (sample A) showed a greater resistance to flow than the other (sample B).

The pore-size distribution measurements were made with a porometer (*14*), which permits the estimation of the total void volume within the boundaries of the sample as well as the density of its structural material. The procedure was essentially the same as described previously (*6*) in that a sample (two or more filter leaves)was placed within the porometer chamber, immersed in mercury, and pressure was applied to cover the range from 1.32 to 1015 lb/in.^{2}. Assuming that all the void spaces were filled with mercury at 1015 lb/in.^{2}, the measured bulk volume per leaf at that pressure is equal to the volume of the filter substance (Table 1). From the weight of the leaf, the calculated density of the filter substance was 1.51 g/cm^3 for both samples A and B. The porosity of the original filter leaf—the percentage of void within its boundaries—was estimated from the bulk densities measured at 1.32 and 1015 lb/in.^{2} and had a value of 79 percent in both cases. This value is in agreement with the 75 to 90 percent values reported in the literature (*8, 10, 11, 13*).

The distribution curves for the two samples practically coincide between 80 and 0.7 μ effective radius,

Table 1. Porometer data for millipore filters (average for single leaf).

	Sample A	Sample B
Bulk volume at 1.32 lb/in.^{2} and 80 μ (cm^3)	0.2655	0.2628
Bulk volume at 1015 lb/in.^{2} and 0.1 μ (cm^3)	.0564	.0547
Total void volume, by difference (cm^3)	.2091	.2081
Percentage void volume (porosity)	79	79
Weight of leaf (g)	.0850	.0826
Density of leaf at 1015 lb/in.^{2} (g/cm^3)	1.51	1.51
Pore-radius position of peak of distribution curve (μ)	0.48	0.58

which corresponds to a pressure range of 1.32 to 150 lb/in.^{2}. Approximately 10 percent of the total experimental void volume is filled by the time the pressure reaches 150 lb/in.^{2}, owing in part, most probably, to the compression of the samples as a whole. At higher pressures, the rate of filling of the void volumes increases rapidly, as is shown by the sharp rise to a peak in each distribution curve, and then gradually decreases so that each curve approximates the base line at 0.1 μ or 1015 lb/in.^{2} (Fig. 1). The data place about 90 percent of the total experimental void volume within a radius range of 0.7 to 0.1 μ, thus agreeing with the channel dimensions as predicted in a preceding paragraph from the description of the filters.

In this region, the void volumes per leaf—the areas beneath the curves (*1*)—are approximately equal for the two samples, but the distribution according to pore-radius dimensions is different. Sample A shows a consistently smaller effective radius than sample B, and the peaks of the distribution curves occur at 0.48 and 0.58 μ, respectively. Since the porosities of the samples are equal, 79 percent, the distribution in the radius range below 0.7 μ is in qualitative agreement with the permeability data (*15*), which show that sample A has a resistance to flow 33 percent greater than sample B at various pressure differentials.

If the channels are cylindrical, the porometer data indicate that the radius dimensions of the channels in sample A are smaller than those of sample B. An alternate interpretation could ensue from a consideration of the definition of effective radius: the radius of a hypothetical circular pore which would admit mercury at the same pressure as that required to force passage through the actual pore regardless of its cross-sectional shape (*5*). The channels in sample A may have the same cross-sectional areas as those in sample B, but they may deviate more from a circular toward an elliptical cross section. They therefore would exhibit a smaller effective radius and screen out smaller particles and, likewise, would present more resistance to flow, since flow is influenced similarly by the cross-sectional shape of the channels.

In general, the results indicate that the effective pore sizes, calculated from mercury-intrusion measurements on the basis of Eq. 2 and its underlying assumptions, are reasonably accurate. The pore-size distribution data obtained by this method should prove useful in theoretical and practical investigations dealing with the characteristics of these and of similar type filters, and, in fact, of a variety of porous materials.

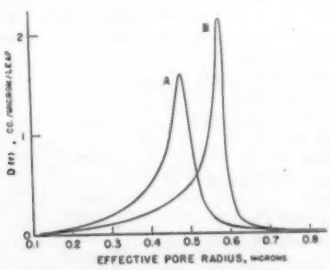

Fig. 1. Pore-size distribution curve, that is, distribution function $D(r)$ versus effective pore radius.

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Processes of Motion Perception

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In an earlier paper (*1*) I discussed the nature of lateral transfer of perceptual organizations. It is believed that a matrix theory of perception can be used as the basis of a unified theory of motion perception. Present theories commonly divide motion perception into two parts. Real motion, in which the perception of movement arises from the movement of an object in real space, is considered different from subjective motion, in which the perceptual organization arises out of the given spatiotemporal complex of stationary stimuli.

It is felt that the two can be related or unified by recourse to a theory of a dual set of organizations, the one corresponding to the perception of motion and the other to the perception of pattern or detail. The basis for this theory lies in two sets of phenomena observed in apparent motion studies.

It is well known that apparent motion perception can be optimized for a particular set of dynamic variables. Below the optimal point, motion tends to disappear and is replaced by the successive appearance of the stimuli. Above the optimal point, it is replaced by simultaneous appearance of the stimuli. Under stimulus conditions reported (*1*), the second stage is characterized by a phenomenon that I have called "Omega." The Omega complex is reported as (i) a black shutter or door that opens to reveal the light source, (ii) a hole in nothing, and (iii) as various

moving objects having object-character derived from the subject's own experiences. This perception evidently corresponds closely to the experience of a moving object under scotopic conditions.

Under optimal conditions, Beta movement (where the moving stimulus corresponds to the physical stimuli) is reported. Beta and Omega are not reported simultaneously. It is felt that the Omega is isomorphic to a movement signal generated by certain temporal aspects of the recurrent stimulus.

We may formulate a tentative law which states that if an area X' is stimulated some time before an area Y' is stimulated, the necessary condition for the perception of motion alone has been met. Detail vision will be a function of the energy level of the stimulus and its temporal duration. If the detail component is barely above the limen, then the motion signal will capture the detail complex. If the energy level of the stimulus is raised, the detail component will register isomorphic to the real space projection of the stimulus, but the temporal conditions necessary to generate the motion signal need not be violated.

The detail component is thus related to the energy level or contrast relationships of the stimulus and ground, whereas the motion component is related to the timing or subjective velocity of traverse of the visual field. Obviously, such organic characteristics as delay time and adaptation act to interrelate the two components.

The foregoing formulation is a restatement of Korte's laws of apparent motion extended to include the case of all perceived motion. It will serve to relate real motion perception, the phenomena of apparent motion, and certain observed perceptual changes in moving objects.

We postulate two neural organizations, one primitive organization, which corresponds to motion perception, and another, isomorphic to detail. The more primitive motion perception mechanism is similar to scotopic vision. It is also more resistant to disruption, so that the detail complex may cease to be associated with the motion signal. If the necessary conditions of successive stimulation of retinal areas is maintained, the perception of Beta motion will break apart into the detail complex and the motion signal.

In this case, we expect the temporal ordering of the stimulus to be the largest single factor in determining motion perception, since the Omega is largely a function of timing, whereas the detail component tends to lose significance at a level barely above the limen. If the energy or contrast level is raised, it merely reflects more detail and will eventually come to anchor the perception of the stimulus object to its real location in space.

When the spatiotemporal aspect of a stimulus configuration duplicates the necessary condition for the motion complex, the assignment of object character to the movement perception arises out of the proximity of the source of energy necessary to create the motion signal. Each component can be isolated and studied under laboratory conditions. Does this mean that we have succeeded in isolating the components of a perceptual organization, or does it mean that perceptual organizations are holistic but tend to combine in a nonlinear manner to form new organizations? Certainly logic will not predict Beta movement from the motion complex and an object in the visual field. Perception is thus removed to a supraordinate level.

Perception of Omega is the perception of a dynamic signal stating that "something has moved" from X to Y. It is entirely distinct from the organization of neural elements which transduce the static physical characteristics of the stimulus object. The supraordinate process combines the two organizations into a new item of intelligence: the moving object is an object in the spatial field.

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11 June 1954.

Communications

Induction of Tooth Defects by Thermal Shock

The large increase in incidence of tooth decay in the United States since the turn of the century has undoubtedly considerable connection with our changed eating habits. One of the changes in eating habits is that of eating intensely cold and hot foods at the same meal. The practice, for example, of eating piping hot food, served at say 150°F, and a moment later taking a swallow of an iced drink, or vice versa, exposes the teeth to some thermal shock. One effect of thermal shocks on vitreous materials is to induce small cracks, which accelerate mechanical breakdown. In the case of teeth such small cracks could also furnish entrance sites for bacterial decay. How important is such thermal shock to the teeth?

To obtain a preliminary idea of how to attack the problem, a number of extracted healthy teeth free of fillings were subjected to repeated thermal shock, then subjected to a smashing action. A comparison was then made of the proportion of the teeth that survived the smashing with the proportion of teeth surviving that had not undergone thermal shock cycling. The test conditions chosen were extremely simple but severe and were intended only to indicate probable trends in tooth behavior.

From the original batch of 160 teeth, half were

selected by a random manner as controls and half were subjected to 72 thermal shock cycles. The 80 teeth to be shocked were placed in a wire basket and alternately shifted from boiling water to ice water containing much finely cracked ice. Emphasis was placed on producing rapid temperature change in the teeth. The teeth were allowed to come to temperature and after 1 min were transferred rapidly to the other temperature bath. The control teeth were boiled for ¾ hr but were heated and cooled slowly to avoid thermal shock. A test was then made of the resistance of the two groups of teeth to fracturing. After sacrificing a few teeth to explore suitable crushing tests, a final comparison of the teeth was begun. A flat-bottomed 6-lb lead weight block was dropped from a height of 7 in. onto individual teeth as they lay on a hard concrete floor. The drop tests were done in alternating groups of 10 teeth from each large group. Of the control group, 11 out of the 50 broke; of the group given the 72 shock cycles, 21 of the 50 tested broke. The results suggest that thermal shock may promote cracks in teeth. Further work on this aspect of dental effects is indicated.

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13 October 1954.

Trisomics in Barley

To date relatively few reports have been published on trisomics in common barley, *Hordeum aestivum* Hall. ($2n = 14$). In his comprehensive review "Cytology and genetics of barley," Luther Smith [*Botan. Rev.* 17, 1 (1951)] cites only three references dealing with trisomics. A series of trisomics would be extremely valuable in cytogenetic studies of barley. So far none of the seven linkage groups has been definitely identified with a particular chromosome. By means of trisomic inheritance studies, it should be possible to associate genes and linkage groups with specific chromosomes.

Trisomic plants were found in the progeny of three triploid barley plants obtained in the F_2 of intervarietal colchicine-treated F_1 hybrids. The parents of triploid 453-11 were an awnless and a hulless type of an unknown variety name, while triploids 1963-4 and 2223-5 were from a cross between Wong and Herta. Except for partial sterility, the triploids resembled normal diploid sibs in general morphological characters. One triploid was found in the progeny of an F_1 plant that also produced diploids and tetraploids. It probably originated from the union of a haploid with a diploid gamete of the same plant. The other two triploids were found in the progeny of different F_1 plants in which no tetraploids were observed. They were probably derived from intercrossing of wholly diploid plants with plants having tetraploid tillers, since the treated generation was grown in confined greenhouse beds.

Table 1. Fertility of triploids.

Triploid plant	No. of florets	No. of seeds	Fertility (%)
453-11	155	15	9.7
1963-4	509	63	12.4
2223-5	360	41	11.4
Total	1024	119	Avg. 11.6

The fertility of the triploids under open pollination in the field is given in Table 1. A total of 119 seeds was produced for an average fertility of 11.6 percent. Table 2 gives the chromosome constitution of 25 mature plants obtained from 61 of the 119 seeds sown in pots in the greenhouse. Nine diploids, 13 trisomics, and three other chromosomal variants were cytologically identified. The latter three plants included one with 14 chromosomes and a large centric fragment capable of forming a heteromorphic trivalent with two normal homologues, one with 15 chromosomes and an acentric fragment, and a third plant with 16 chromosomes. Since the 16-chromosome plant was identified by mitotic counts of somatic anther tissue, it was not possible to determine whether it was doubly trisomic or tetrasomic.

All trisomic plants and the three other variants were partially self-fertile. The fertility of the trisomics, including a few heads pollinated with normal pollen of diploids, ranged from 20.4 to 66.7 percent. The fertility of the three plants having 14 chromosomes and a centric fragment, 15 chromosomes and an acentric fragment, and 16 chromosomes was 50.7, 37.6, and 23.7 percent, respectively.

Since the trisomic plants were derived from highly heterozygous material, it was not possible to attribute any morphological characteristics to the trisomic condition. However, it is possible that one or more constant morphological characteristics will be observed in the trisomic progeny of the original trisomic plants that are presently being grown in the field. Positive identification of the chromosome involved in each of the trisomic lines may be possible by one or a combination of the following methods: (i) study the morphology of the mitotic chromosome complement of each trisomic line; (ii) backcross each trisomic line to a pure diploid in order to attain homozygosity and then observe the phenotypic effects of the extra chromosome; (iii) cross each homozygous line to the

Table 2. Chromosomal constitution of triploid progeny.

Triploid plant	No. of seeds sown	No. of mature plants		
		Diploid	Trisomic	Other
453-11	11	0	0	0
1963-4	33	8	7	1
2223-5	17	1	6	2
Total	61	9	13	3

seven available linkage testers and make identification on the basis of trisomic ratios.

This investigation is being supported by the National Research Council of Canada in the form of a studentship.

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4 October 1954.

Inverse Relationship between the Water Content of Seeds and Their Sensitivity to X-rays

It was early established in radiobiological investigations that seeds with a high water content were more susceptible to x-rays than seeds with a low water content (*1*). A similar relationship has been demonstrated for the ascospores of *Aspergillus terreus* (*2*). These and other such studies have been taken to support the contention that, in addition to being affected by the direct absorption of energy from ionizing radiations, sensitive sites are affected indirectly through the chemical action of active radicals produced in the presence of water (*3*).

If the role of water in the sensitizing of a system to x-radiation is in a large part due to chemical events incited through radical production, it would seem reasonable to assume that in any biological system in which the water content could be varied over rather wide limits, the radiosensitivity of the system would increase with increasing water content. This should be true at least until such time as an optimum production of radical species that could contribute to injury had been produced.

To test this assumption (*4*) seeds were soaked at 3°C for various periods of time from 1½ to 24 hr. Their sensitivity to x-rays, as determined by seedling heights at 7 days, was then compared with that of unsoaked seed. It was found that their water content could be increased from 7 percent of their total weight in the unsoaked seeds to about 20 percent in the soaked seeds before there was an increase in their radiosensitivity. The steeping time required to increase their water content to this level was from 1½ to 3 hr. Increasing the water content of the seeds above 20 percent resulted in a striking increase in radiosensitivity.

These experiments were suggestive of the possibility that water content *per se* may not be responsible for the increased radiosensitivity of seeds with a high water content in comparison with seeds having a low water content. However, it was realized that because of the short periods of soaking required to raise the water content of the seeds to 20 percent, the water may not have been "effectively" distributed in the seed. For this reason it was decided to increase the water content of seeds by permitting them to reach weight equilibrium in desiccators over salt solutions with different vapor pressures. Using this procedure it was possible to obtain the following water contents of different lots of seed: 7, 9, 13, 16, and 24 percent.

When seeds with these water contents were subjected to x-rays it was found that there was an inverse relationship between the water content of the seeds and their radiosensitivity (Fig. 1). This relationship held true for doses of 10,000, 20,000, 30,000, 40,000, and 50,000 r.

It should be pointed out that the seeds with 24 percent water only maintained equal viability to seeds with 7 percent water for a period of about 14 days. However, during the course of these investigations seedling growth studies indicated that the viability of the other seeds used in the study was not affected by the storage conditions.

The question arises whether or not the decreased radiosensitivity that was observed when the water content of the seeds was increased from 7 percent to about 20 percent was due to the physical presence of additional water in the seed or resulted from some other factor(s), possibly those associated with increased metabolic activity. The experimental evidence suggests that the phenomenon observed is directly related to the water content of the seeds, because when seeds with about 16 percent water were desiccated over dry $CaCl_2$, until they contained about 7 percent water, their radiosensitivity increased.

If the modifications in radiosensitivity reported here can be validly attributed to variations in water con-

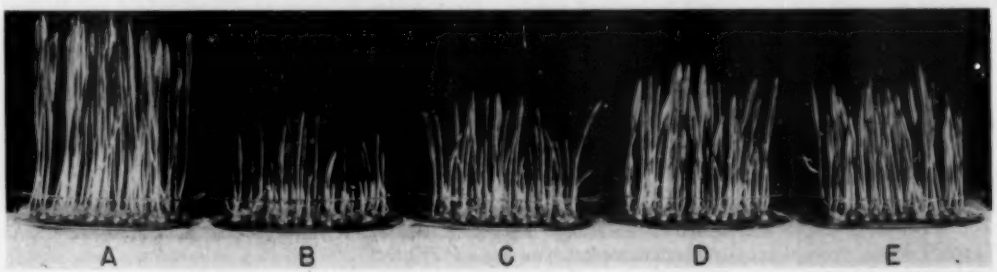

Fig. 1. Seven-day-old seedlings from seeds that reached weight equilibrium at the following relative humidities and were then subjected to 20,000 r of x-rays: (*A*) Control (no treatment); (*B*) 0.0; (*C*) 32.2; (*D*) 52.0; (*E*) 75.0.

tent, it is apparent that there is not a 1-to-1 relationship between the water content of seeds and their sensitivity to x-rays. This suggests that reduced seedling height resulting from x-radiation is not simply related to the production of active radicals in the presence of water.

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10 September 1954.

In vitro Studies of Dental Decay*

The concept of studying the carious process by using extracted human teeth under *in vitro* conditions was realized and applied early in the development of dental research. E. Magitot (1870) and W. D. Miller (1890) described carious lesions produced in this manner (*1*).

Recently the value of *in vitro* studies has been increased by the development of the "artificial mouth" (*2*). For this work, extracted human teeth are mounted singly or in pairs. The mounted teeth are placed in cylindrical funnels, and a bacteriological medium ("artificial saliva") is allowed to flow dropwise over the teeth for several months. At weekly intervals, the teeth are inoculated with pooled samples of human saliva and rapidly become covered with a mass of microorganisms.

Some of the most important factors that have been found to influence the destruction of the teeth are the following. Tooth destruction can be quite general, if localizing factors are not present. If the teeth are cleansed regularly, destruction will be confined mainly to the noncleansed areas, to previously abraded areas, and to the cervical areas. Old teeth appear to be more resistant than young or unerupted teeth, and there is evidence for the presence of a protective surface film (*3*). The attack is greatly influenced by the amount of D-glucose in the nutrient medium. With only a small amount present (< 0.10 percent), sound teeth remain unchanged for long periods. In the presence of a relatively large amount (for example, 0.5 percent D-glucose), enamel attack and decalcification of exposed dentin proceed rapidly. At intermediate concentrations (0.2 to 0.3 percent), both decalcification and dentinal matrix destruction occur, so that the entire tooth structure will be destroyed.

More recently, several additional important observations have been made. Because of the considerable delay in publication and a desire to extend this work before publication, a brief summary is presented here.

Reidar F. Sognnaes (Harvard School of Dental Medicine) has examined histologically thin sections from a number of teeth with localized lesions of enamel and of dentin, produced in the "artificial mouth." The sections were found to exhibit a number of features associated with natural lesions. According to Sognnaes, these are the following. (i) Accumulation of plaques containing gram-positive microorganisms has been demonstrated on tooth surfaces subjected to various bacterial substrates in the "artificial mouth." (ii) The primary penetration of the enamel appeared to proceed between the prisms, accompanied by accentuation in the appearance of the prisms, the cross-striations, and the incremental lines, eventually followed by a loss of surface continuity. (iii) Invasion of the dentin occurred along characteristic tracts, indicated by greater permeability to dyes and, eventually, followed by loss of tooth substance and cavity formation. (iv) A predominance of gram-positive spheroid microorganisms could be demonstrated within distended dentinal tubules, eventually invading the ramifications of the tubules and destroying the intertubular matrix.

More recently, several experiments have been concluded in which the attack was brought about by single strains of microorganisms. Under conditions such that both decalcification and dentinal matrix destruction would occur with mixed cultures, it was found after 3 mo that an oral *Lactobacillus casei* strain produced decalcification but did not affect the matrix. On the other hand, an oral *Streptococcus salivarius* strain (found later to have become contaminated with a micrococcus) produced decalcification and matrix destruction. The partially attacked dentin was brown and leathery. These experiments are being repeated and extended to other microorganisms. In view of the usually accepted role of lactobacilli in the carious process, these results seem particularly interesting.

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* This work has been aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Alabama (NR 180-017).
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25 June 1954.

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SLEEPING ACCOMMODATIONS AT 121st AAAS MEETING

Berkeley, California, December 26-31, 1954

The hotel, motel, and dormitory sleeping accommodations—their rates and the application coupon below—are for your convenience in making room reservations in Berkeley. Please send your application *directly* to the AAAS Housing Bureau and thereby avoid delay and confusion. The experienced Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **Single rooms may become scarce; double rooms for single occupancy cost more; if possible, share a twin-bedded room with a colleague—and also save.** Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival and also probable date of departure.

HOTELS	SINGLE	DOUBLE	TWIN	SUITE
Claremont	5.00–11.00	8.00–13.00	8.00–13.00	14.00–20.00
Durant	4.00– 7.00	6.00– 9.00	6.50–10.00	10.00–16.00
Shattuck	5.00–10.00	7.00–10.00	7.50–10.00	10.00–18.00
Other hotels	3.00– 5.00	3.50– 5.00	4.00– 6.50	7.00–10.00

(Note: Most hotels have singles without private bath at $2.00–$3.50 per night)

MOTELS				FAMILY ROOMS
Berkeley Plaza	5.00	6.00	7.00	8.50–12.00
California	4.00– 4.50	4.50– 5.00	5.50	6.00– 7.00
Golden Bear	4.50– 5.00	5.00– 7.00	6.00– 8.00	7.50–10.00
Other motels	4.00– 5.00	4.00– 6.00	5.50– 8.50	6.00–12.00

Dormitory Accommodations: NOTE: The 766 units in the University of California dormitories are **primarily for students, younger faculty members, and those not on expense accounts. Occupancy, two persons per room; rate, $2.00 the first night, $1.00 per night thereafter, per person.**

International House: Singles only, *without private bath*, $2.50 per night.

For a discussion of the headquarters of the participating societies and sections, please see Association Affairs, *Science*, July 23, or *The Scientific Monthly*, August.

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
2223 Fulton Street
Berkeley 4, California

Date of Application .....

Please reserve the following accommodations for the 121st Meeting of the AAAS in Berkeley, Dec. 26–31, 1954:

First Choice ..... **Second Choice** ..... **Third Choice** .....
(State name of hotel, motel, or other)

..... Single Room Desired Rate ..... Maximum Rate .....
..... Double-bedded Room Desired Rate ..... Maximum Rate .....
..... Twin-bedded Room Desired Rate ..... Maximum Rate .....
..... Suite Desired Rate ..... Maximum Rate .....
..... Dormitory Unit(s)—two persons per room at $2.00 each first night, $1.00 per night thereafter.

HOTEL AND MOTEL ROOM DEPOSIT

$5.00 per reservation or $10.00 per room (*refunded if cancelled before Dec. 17*)

Make checks payable to "AAAS Housing Bureau."

The name and address of each person, including yourself, must be listed. Attach list if this space is insufficient.

.....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

My society (or sectional interest) is: .....

I (will) (will not) have an automobile at the Meeting.

Mail this now to the Housing Bureau (address above). *Enclose hotel or motel room deposit. Make checks payable to AAAS HOUSING BUREAU.* **Rooms will be assigned and confirmed in order of receipt of reservation.**

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Meetings & Conferences

December

8–10. Eastern Joint Computer Conf., 4th annual, Philadelphia, Pa. (EJCC, P.O. Box 7825, Philadelphia 1.)

8–10. Western Forestry Conf., San Francisco, Calif. (C. S. Martin, 712 U.S. Natl. Bank Bldg., Portland 4, Ore.)

9–11. Texas Acad. of Science, annual, San Antonio, Tex. (G. H. Baird, P.O. Box 228, Huntsville.)

10–12. Florida Acad. of Science, Tallahassee, Fla. (R. A. Edwards, Dept. of Geology, Univ. of Florida, Gainesville.)

11–14. American Acad. of Optometry, annual, Toronto, Canada. (C. C. Koch, 1502 Foshay Tower, Minneapolis 2.)

11–22. World Forestry Cong., 4th, Dehra Dun, India. (T. Street, Foreign Agricultural Service, U.S. Department of Agriculture, Washington 25.)

12–15. American Inst. of Chemical Engineers, annual, New York, N.Y. (AIChE, 120 E. 41 St., New York 17.)

26–28. American Statistical Assoc., Berkeley, Calif. (S. Weiss, 1108 16 St., NW, Washington 6.)

26–29. National Science Teachers Assoc., Berkeley, Calif. (R. H. Carleton, 1201 16 St., NW, Washington 6.)

26–30. Inst. of Mathematical Statistics, Berkeley, Calif. (K. J. Arnold, Dept. of Mathematics, Michigan State College, E. Lansing.)

26–31. AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, annual, Berkeley, Calif. (R. L. Taylor, 1515 Massachusetts Ave., NW, Washington 5.)

26–31. American Nature Study Soc., Berkeley, Calif. (H. B. Ross, State Teachers College, Fitchburg, Mass.)

27. Metric Assoc., Washington, D.C. (V. G. Shinkle, 1916 Eye St., NW, Washington 6.)

27–28. American Folklore Soc., New York, N.Y. (M. Leach, Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

27–28. Ecological Soc. of America, Berkeley, Calif. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

27–29. American Mathematical Soc., annual, Pittsburgh, Pa. (E. G. Begle, AMS, Yale University, New Haven, Conn.)

27–29. Arctic Inst. of North America, Berkeley, Calif. (R. C. Wallace, 4 Centre St., Kingston, Ont., Canada.)

27–29. Astronomical Soc. of the Pacific, Berkeley, Calif. (S. Einarsson, Leuschner Observatory, Univ. of California, Berkeley 4.)

27–29. International Conf. on Animal Venoms, Berkeley, Calif. (N. Porges, Eastern Regional Research Laboratory at Wyndmoor, Philadelphia, Pa.)

27–29. Soc. for Industrial and Applied Mathematics, 1st, Pittsburgh, Pa. (H. W. Kuhn, Dalton Hall, Bryn Mawr College, Bryn Mawr, Pa.)

27–29. Western Soc. of Naturalists, Berkeley, Calif. (J. L. Mohr, Univ. of Southern California, Los Angeles 7.)

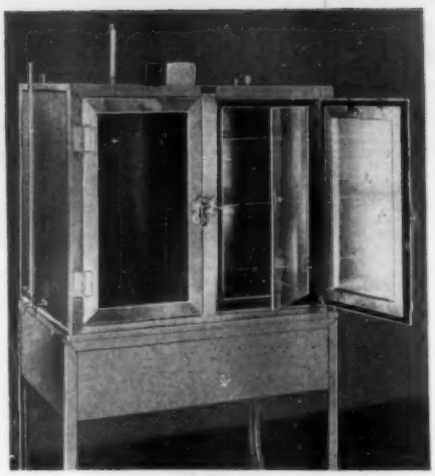
27–30. Berkeley Symposium on Mathematical Statistics and Probability, 3rd, Berkeley, Calif. (J. Neyman, Dept. of Mathematics, Univ. of California, Berkeley 4.)

27–30. Econometric Soc., Detroit, Mich. (R. L. Cardwell, Cowles Commission, Univ. of Chicago, Chicago 37.)

27–30. National Assoc. of Biology Teachers, Berkeley, Calif. (P. Webster, Bryan City High School, Bryan, Ohio.)

27–30. Soc. of Systematic Zoology, Berkeley, Calif. (R. E. Blackwelder, U.S. National Museum, Washington 25.)

(See issue of 22 October for more comprehensive listings.)



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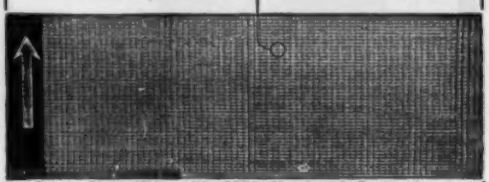

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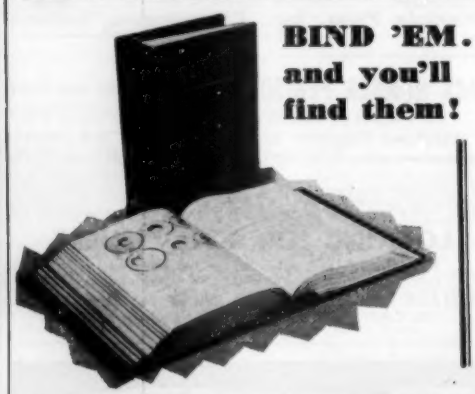

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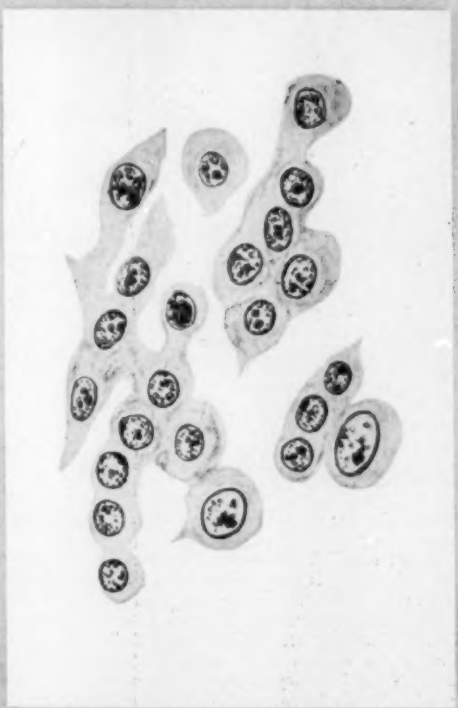

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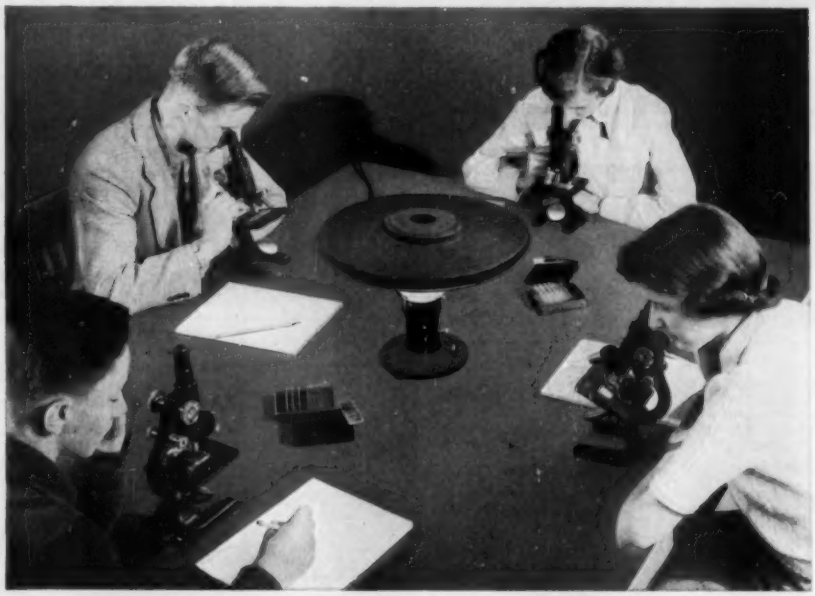

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